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ART. XXXVIII.—*On some points in Lithology;* by JAMES D. DANA.

I. ON SOME OF THE CHARACTERS EMPLOYED IN DISTINGUISHING DIFFERENT KINDS OF ROCKS.

LITHOLOGY is a department of Geology, rocks being the material in and through which geological problems are presented for study. The true aim of the science of lithology is to describe the kinds of rocks mineralogically and chemically, and to note down their distinctions, in such a manner as shall best contribute to the objects of geology; and these latter objects include, as regards rocks, the origin of the minerals, and mineral associations, constituting or occurring in rocks: the origin of the rock masses and their relations to other geological phenomena; and the origin of all changes or transformations that have taken place in rocks in the course of the earth's physical development. Geology, chemistry and mineralogy have each to be considered in determining the proper distinctions between the kinds of rocks. Should lithology make much of mere difference in texture, or in ingredients that are present only in minute proportion, geology might rightly say that, for such a purpose, these points are of small importance compared with the nature or composition of the mass.

The defining of rocks is attended with special difficulties on account of their mutual transitions. From granite down they are, with very few exceptions, mixtures of minerals, as much so as the mud of a mud bank. They graduate into one another by indefinite blendings, as the mud of one mud bank graduates into the mud of others around it. In fact a large part of the

crystalline rocks were once actual mud beds or sand beds; and even part of the eruptive rocks may have been so in their earlier history. Strongly drawn limits no where exist. Rocks are hence of different *kinds*, not of different *species;* and only those mixtures are to be regarded as *distinct kinds* of rocks which have a sufficiently wide distribution to make a distinct name important to the geologist. Other kinds have to be classed as *varieties*, if worthy of that degree of recognition.

In the following pages I propose to consider the value of some of the distinctive characters which are generally accepted at the present time in defining certain kinds of rocks.

1. "*Older*" *and* "*Younger.*"—The distinctions "older" and "younger," often applied to a number of kinds of eruptive rocks, seem to imply that the earth has generated different *kinds* of rocks as it has grown old. The terms have reference, however, to only one epoch of abrupt change—that between the Cretaceous and Tertiary, "older" signifying pre-Tertiary and "younger," Tertiary or later in date. It is of eminent importance to geology to know definitely whether this epoch was one of great change in the earth's ejections, and an epoch so marked that the rocks on one side of the time-boundary are deserving generally of different names from those of the other; for thus lithology, judging from some recent works, as well as older, has seemingly decided.

Some examples of the "older" kinds are *dioryte*, *diabase*, and a large part of *felsyte;* and some of the "younger" are *propylyte*, *doleryte* or *basalt*, and *trachyte*. The value of the distinction may be learned from a comparison of the rocks of one of these series with the rocks of the other.

First as to *diabase* and *doleryte*. Typical diabase consists, according to the descriptions, of labradorite and augite, with some magnetite or titanic iron: and so does doleryte. Diabase, to a large extent, is a crystalline-granular rock; so is doleryte. Diabase was formerly supposed to be peculiar in containing chlorite, but it is now proved, as asserted by Rosenbusch, that chlorite is not an essential characteristic, so that diabase may be chloritic or not; and the same is true of doleryte. Old diabase was described as differing from the younger rock doleryte in containing no glassy portions or grains among the crystalline grains; but this also is set aside by later observations, and Rosenbusch accordingly divides diabase into (1) massive granular diabase, (2) diabase-prophyrite, and (3) glass-bearing diabase; and corresponding subdivisions are as good for doleryte. Thus in chemical composition, in mineral composition, in texture, in the presence or absence of chlorite, in the presence or absence of glassy portions, the two rocks are identical. Analyses of "diabases" from the Archæan to the Tertiary, and of

"dolerytes" of subsequent time, have shown that material of essentially the same chemical composition, has been ejected in all geological ages, as has been well urged by Allport and others. The analyses might be cited; but this is not necessary, since in mineral composition typical diabase and doleryte are admitted to be identical.

The fact as regards these two rocks, then, give no foundation for the idea of such a transition epoch in rock-making at the close of the Cretaceous period. And if not, it is bad for geology to have such epithets as "younger" and "older" treated with so great distinction.

Again: the difference between *dioryte* ("older") and *propylyte* ("younger") is not in the chemical or mineral composition of the rocks; and hence, whatever difference there be is only in texture and is, therefore, of little geological value.

Again, *felsyte* and *trachyte* are rocks of one and the same chemical and mineral constitution. Ordinary felsyte consists of orthoclase, or orthoclase and oligoclase, with sometimes disseminated hornblende or quartz; and the same is precisely the constitution of kinds of trachyte. They differ in aspect, and feel differently under the fingers; and still some varieties of felsyte differ from ordinary trachyte only in having the disseminated orthoclase crystals not translucent, a difference of very small value mineralogically and not less so geologically. The rock of certain felsitic dikes in Canada and Vermont, Paleozoic in age, is called trachyte by T. Sterry Hunt, in the Canada Geological Report, because of the essential identity with that rock; and Mr. G. W. Hawes, in his New Hampshire Report says (p. 187), of New Hampshire's "orthoclase-porphyry," "were it not that the feldspar is opaque orthoclase instead of clear sanidin [that is, glassy orthoclase] one would immediately think of trachyte on examining these rocks." Moreover, Messrs. E. Reyer and Suess, eminent geologists of Vienna, have shown that trachyte occurs in the Euganean Hills of Cretaceous and Jurassic age, as well as of Tertiary. Further, there are felsytes among the "younger" rocks of the globe, that is, among the products of volcanoes, where there is no trachyte; and on the other hand, trachyte sometimes graduates indefinitely into felsyte.

The facts show, consequently, that orthoclase rocks, or orthoclase and oligoclase, have been erupted from Paleozoic time onward, and that the distinctions found in some of the latest kinds are superficial: a little rougher surface, more translucency in the feldspar, and some glass at times among the crystalline grains; but nothing that has any geological weight. While then it may be well to retain the names of trachyte and felsyte, on account of the obvious external differences and the

wide extent to which the two varieties of rock are distributed over the earth's surface, the epithet "younger" as applied to trachyte and some felsyte can subserve plainly no good use.

The essential chemical identity of the "older" and "younger" rocks is further exhibited in the fact that the hornblende-bearing rock *labradorite-dioryte*, called one of the "older," has the same ultimate constitution as the augite-bearing rocks "older" and "younger," called diabase, doleryte and basalt. This fact emphasizes the great truth, that the rock-making materials of former time are the same as those of recent.

During and since the Tertiary era more true subaerial volcanic eruptions have taken place than in any one ancient period; but there were also many then. As to fundamental differences between the materials ejected by the "older" and "younger" world there appear to be none which are of essential importance. *Glass or no glass* is made an important criterion; but glass is simply a result of comparatively rapid cooling and alone indicates no essential differences in the melted mass.

Dropping the adjectives "younger" and "older" would require the dropping of the distinctive names based on them, unless some better reason exists for retaining them.

If diabase is not distinct from doleryte in some important way besides that of time of eruption, the name *diabase* (the newer of the two) is unnecessary. In fact, the rocks are not distinct in external characters any more than in chemical or mineralogical. The rock of the Giant's Causeway was pronounced diabase on microscopic grounds when its geological age was unknown; but it has since been proved to be Miocene Tertiary; and now although just as much diabase in constitution as before, it becomes, on the "younger" and "older" scale, doleryte or basalt.

Some of the differences attributed to difference in age may be due to differences in origin—that is, to the rock's being metamorphic in one case, and eruptive in another. There are distinctions of this kind of great interest yet to be followed out; and they may sometimes have a sufficient geological value for recognition in distinct names, although this may not be generally the case.

2. *Foliated or not.*—Some rocks are described as having foliated pyroxene or foliated hornblende, that is, diallage, pseudo-hypersthene or smaragdite, as the characterizing ingredient. The question here is whether the distinction of *foliated* or *not foliated* is of sufficient importance to be used as a distinction among kinds of rocks.

In the *first* place it is trivial as a crystallographic distinction. *Secondly*, although mineralogy once made much of the distinc-

tion, it now makes little of it. *Thirdly*, it is not sustained by the analyses of the varieties of foliated pyroxene—diallage, and the wrongly called hypersthene being essentially identical in composition with common augite of eruptive rocks, and the smaragdite with other crystallized hornblende. This is shown in any work giving full lists of analyses of minerals, and is well understood; yet the introduction here of a few of the analyses may not be superfluous. Nos. 1 to 5, are of diallage and pseudo-hypersthene, and 6 to 8 of augite crystals from Etna and Vesuvius.

	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	H_2O	
1. Florence, *Diall.*...	53·20	2·47	8·67	0·38	14·91	19·09	1·77	=100·49, Köhler.
2. Piedmont, *Diall.*..	50·05	2·58	11·98	—	17·24	15·63	2·13	= 99·61, Regnault.
3. Graubündten, *Diall.*	49·12	3·04	11·45	—	15·33	18·54	1·46	= 99·94, v. Rath.
4. Harzburg, *Hyp.* ..	52·34	3·05	8·84	—	15·58	19·18	0·66	= 99·65, Streng.
5. Neurode, *Hyp.* ...	53·60	1·99	8·95	0·28	13·08	21·06	0·86	= 99·82, v. Rath.
6. Etna, *Augite Cryst.*	50·55	4·85	7·96	—	13·01	22·29	—	= 98·66, Kudernatsch.
7. Vesuvius, "	50·90	5·37	6·25	—	14·43	22·96	—	= 99·91, Kudernatsch.
8. Vesuvius, "	49·61	4·42	9·08	—	14·22	22·83	—	=100·16, Rammelsberg.

The mineralogical and chemical differences are thus too slight to make the distinction of any lithological importance, and this importance can be sustained, if at all, only on geological considerations.

The particular rock, in the description of which the character stands prominent, is that called *Gabbro* in Germany. It is well known that this Italian word was the provincial name originally of common serpentine. Ferber in his "Briefe aus dem Wälschland" (Letters from Italy), written in the years 1771, 1772, and published in 1773, describes so well the rock near Florence, that we cite briefly from him. He first says, in a letter from Florence of Dec. 11, 1771, (in which he gives scientific notes on the minerals and rocks of the region) that the Gabbro of the Italians, occurring in Italy, Tuscany and Genoa, is identical with the serpentine of Saxony. Then, in another, of May 23, 1772, he repeats the statement and describes particularly, and with scientific precision, the gabbro of Mt. Impruneta, near Florence, and mentions the occurrence in it of a talky micaceous mineral which affords, he says, a powder greasy to the touch (the diallage) and also amianthus. He then adds that "in *horizontélen* Schichten in den Gabbro-Bergen um Impruneta findet sich der sogenannte *Granitone*, welcher aus weissen Feldspat, der an einigen Stellen Kalchspatartig ist und mit Säuren brauset, etwas grünlichtem silberfarbigen würflichten Glimmer, und grünlicher Serpentin-Erde, besteht:" a description that distinguishes the gabbro from the granitone. Further, he says, that some of the granitone consists of the "white feldspar in large parallelopipeds and green gabbro-earth, without the micaceous mineral."

The word *Gabbro*, as it is now used (and was so first by von Buch in 1810) is applied to the *granitone*, the associate of the Italian gabbro; but, besides this, to rocks consisting of foliated pyroxene (sometimes called hypersthenite), and cleavable labradorite the idea of *foliated* standing out prominently; and also to an eruptive diabase-like or doleryte-like rock, in which the augite happens to be *foliated*.

In this last variety, as the analyses show, there is evidently no foundation whatever for separating the rock from other labradorite-augite eruptive rocks.

Granitone is the same as *euphotide*, a rock distributed at intervals along the Alps from Savoy and Isère in France through Piedmont, to the valley of the Saas, north of east of Monte Rosa, and the Graubündten, occurring also in Silesia and on the island of Corsica, and found commonly associated with serpentine. Its chief characteristic is—not its *foliated* diallage or smaragdite (either of which is usually a mixture of hornblende and pyroxene), but its consisting largely of the compact jade-like material called *saussurite;* for it would be the same rock, essentially, whether the hornblende and pyroxene were distinctly foliated or not; and, in fact, in part of it the texture is aphanitic, and nothing foliated is distinguishable.

Saussurite has a close relation to some of the feldspars in its constituents, it being essentially a soda-lime-alumina silicate; and still, as has long been recognized, it is not a feldspar. This has been rightly sustained by the fact of the high density, which is over 2·9 (2·9 to 3·4), in saussurite, and less than 2·765 in the feldspar group. It is further proved by its occurrence occasionally under the crystalline forms of a triclinic feldspar, but with a fine granular or aphanitic structure; thus having, instead of the cleavage structure belonging to the feldspar, a feature belonging to a pseudomorph. In such cases it was once feldspar; but some change has come over it that has resulted in a molecular transformation, affecting both the crystalline character and the density. Saussurite appears to cover a group of minerals, like feldspar. *One* kind is between anorthite and zoisite in composition, though differing from both in the soda and magnesia, and from all feldspars in its not having the feldspar-ratio between the silica and soda. A *second* has the composition of labradorite; and a *third* the composition nearly of oligoclase. A *fourth*, from Corsica, analyzed by Boulanger, is a lime-alumina silicate, like anorthite and zoisite. The saussurite group, with density between 2·9 and 3·4, runs nearly parallel with the feldspar group. The first is *Saussurite*, Th. de Saussure having named thus the Lake Geneva variety, after his father, in 1806; the third is *Jadeite;* and the second may be called, from one of its localities, *Genevrite*.

The following are analyses of the three prominent kinds, and of normal anorthite, labradorite and oligoclase.

		SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	ign.	
	I.										
1.	L. Geneva	43·59	27·72	2·61	—	2·98	19·71	3·08	—	0·35	=100·04, Hunt.
2.	L. Geneva	45·34	30·28	—	1·37	3·88	13·87	4·23	—	0·71	= 99·68, Fikenscher.
3.	Schwartzwald	42·64	31·00	—	2·40	5·73	8·21	3·83		3·83	= 97·64, Hütlin.
	II.										
4.	Mt. Genèvre	49·73	29·65	—	0·85	0·56	11·18	4·04	0·24	3·75	=100·00, Delesse.
5.	Silesia	50·84	26·00	2·73	—	0·22	14·95	4·68	0·61	1·21	=101·24, v. Rath.
6.	Silesia	51·76	26·82	1·77	—	0·35	12·96	4·61	0·62	0·68	= 99·57, Chandler.
7.	Unst	52·21	29·64	0·48	—	0·26	12·43	4·00	0·44	0·11	= 99·56, Heddle.
8.	Unst	53·14	29·99	0·25	—	0·21	12·29	3·86	0·47	0·21	=100·42, Heddle.
9.	Durance	56·12	17·40	7·79	—	3·41	8·74	3·72	0·24	1·93	= 99·35, Delesse.
	III.										
10.	*Jadeite*, China	59·17	22·58	—	1·15	1·15	2·68	12·93	*tr.*	—	=100·07, Damour.
11.	" Switz.	58·89	22·40	—	1·28	1·28	3·12	12·86	0·49	0·20	=100·63, Fellenberg.
12.	" "	58·28	21·86	—	2·41	1·99	2·53	13·97	—	—	MnO 0·22, Fellenb.
13.	Normal anorthite	43·1	36·9	—	—	—	20·0	—	—	—	=100
14.	Normal labradorite	52·9	30·3	—	—	—	12·3	4·5	—	—	=100
15.	Normal oligoclase	61·9	24·1	—	—	—	5·2	8·8	—	—	=100

Specific gravity of 1, 3·227; of 2, 3·3–3·4; of 3, 3·16; of 4, 3·10; of 5, 2·998; of 6, 2·74; of 7, 2·95; of 8, 2·954; of 9, 2·923; of 10, 3·33–3·35; of 11, 3·32; of anorthite, 2·66–2·763; of labradorite, 2·67–2·76; of oligoclase 2·56–2·72.

To No. 9, add Cr_2O_3 0·51, and to 11, ZnO 0·73. Nos. 10 to 12 are only known worked into ornaments, but the kind may yet be found in the Alps. No. 6 has the specific gravity of labradorite and was therefore that species, a mineral that would be present where the crystallization took place without, or with only partially, the conditions needed to produce saussurite. No. 9 is of the globules of the "Variolite of Durance," a rock associated with euphotide.

Boulanger's saussurite, from Corsica, is near *zoisite* in composition and density (G.=3·18), as stated by T. S. Hunt, who referred all true saussurite to zoisite (confirming his view by his analysis above), and the part near labradorite to that of feldspar. Damour obtained for *jadeite* the ratio 1 : 2 : 6.

The relation to the feldspar group indicates the occurrence of special geological circumstances, which turned feldspathic material into saussurite. The circumstances that determined the crystallization or metamorphism may have produced, in its incipient stage, soda-lime feldspar; but it ended in making a large *part*, or the *whole*, saussurite. Moreover the hornblende has been shown to be in part, at least, pseudomorphous after pyroxene; so that the foliated ingredient bears like evidence in favor of this mode of origin. Consequently saussurite rocks not only differ molecularly from any labradorite or feldspar rock, but are indications of peculiar geological operations on a large scale; and this, connected with other differences, makes it desirable to distinguish such rocks by a special name. The saussurite, and not the *foliated* mineral, is the chief ingredient on which the distinction rests.

Euphotide is therefore a different rock from any consisting of *cleavable* labradorite and pyroxene or hornblende, both on mineralogical and geological grounds. The *foliated* condition of the latter constituent is not reason enough for overlooking

the more fundamental differences. As the name *gabbro* has covered rocks of so different kinds, lithology would be freer of ambiguities without it.

The true labradorite-and-pyroxene rock of Scandinavia, the Adirondacks, British America and other regions, sometimes called *Noryte*—the third kind of gabbro—has the chemical and mineralogical constitution of diabase or doleryte. But it differs from these in its granitoid aspect and geological relations, and is of metamorphic origin; and as it is of wide geographical distribution, geology seems to require for it a distinct name, and *noryte* is an appropriate one. The pyroxene, though generally foliated, is not always so. When, in place of pyroxene, there is *true* hypersthene, a mineral of different composition and character, as at St. Paul's, Labrador, the rock is then rightly called *Hypersthenyte*, and this name is so used by Zirkel.

3. *Porphyritic Structure.*—Porphyry naturally took the position of a species in the mineralogy of the ancients. But it is now well known, and generally admitted, that the porphyritic structure is largly due to conditions attending the former temperature and cooling of the rock-mass, and distinguishes only varieties. But still it is usual to find dioryte divided, for its primary subdivisions, into ordinary dioryte and dioryte-porphyry; diabase into granular diabase and diabase-porphyry or diabase-porphyrite; felsyte into felsyte and felsyte-porphyry; and so on, as if the porphyritic structure were deserving of first prominence in the question of division into varieties, even greater than mineral constitution; and sometimes it is even made the basis of a distinct kind of rock.

But, *first*, this porphyritic feature is only one grade in the crystalline condition, and is of no more value as regards rock-distinctions than other grades.

Secondly, it is of far less importance in this respect than any variations in chemical or mineral compositions, such as are made the basis of other varieties.

Thirdly, it has often little stability in a rock-formation; for transitions in a dioryte from porphyritic dioryte to non-porphyritic are often found to take place at short intervals, laterally as well as vertically; and so it is with other porphyritic rocks. Within three miles west of New Haven, Connecticut, a labradorite-dioryte undergoes many such transitions in intervals of a few rods, illustrating the little value of the distinction based merely on this condition in the feldspar. Half a dozen miles farther west there is porphyritic granite which graduates *in a few yards* at some points into porphyritic gneiss (the crystals of orthoclase, two inches long and three-fourths of an inch broad) and this last graduates near by into ordinary gneiss; and gradations from porphyrytic to ordinary

gneiss are very common in the region. Such facts make it evident that the porphyritic structure is a characteristic of little relative importance; that a porphyritic variety may have rightly a place on a level with other ordinary varieties, but never above one based on variations in composition.

The porphyritic structure is an easy character to observe, but this is not an argument in its favor that science can entertain. Such names as *felsite-porphyre*, *amygdaloporphyre*, *granito-porphyre*, *melaphyre* (this last signifying "black porphyry") and others (abbreviated sometimes to felsophyre, amygdalophyre, granophyre, etc.) have high authority. But they seem to belong rather to books on polished stones than to scientific works on lithology.

The occurrence also of the augite of an eruptive rock in distinct crystals, or of quartz in double pyramids, and other similar cases, can have nothing more than a small *varietal* value. The criterion—crystals or not—is sufficient to distinguish only varieties in mineralogy; and lithology can rightly make no more of it.

[To be continued.]

ART. XXXIX.—*On the Spectrum of the Corona;* by W. T. SAMPSON, U. S. N.

SO FAR as I can learn from the daily papers, there seems to be a considerable unanimity of opinion as to the nature of the light of the corona. My observations, made at Separation, with Prof. Newcomb, lead me to a somewhat different conclusion from those above referred to; I therefore ask leave to describe my work.

Like many other observers of the eclipse I had set myself the task of determining the source of the light of the corona; and this I *attempted only* so far as to decide by the presence or absence of dark lines in the spectrum of the corona, whether the light was the reflected light of the sun or due to the self-luminous material, or whether it was due to both these combined. For this work I used a direct vision five-prism spectroscope, made by Browning, attached to an equatorially mounted telescope of $3\frac{1}{2}$ inch aperture and about five feet focal length. In addition I had prepared to use a hand polariscope consisting of a double-image prism and mica plate. These were the best tools for the work at my command. A few days before the eclipse Mr. Lockyer asked me, if time permitted, to examine with a radial slit whether the 1474 line came close down to the sun's surface or broke off some distance above it. Previous observers were somewhat at variance as to the fact

and upon it seemed to depend the simple or compound nature of the gas emitting the green light. I therefore determined to commence my work by adjusting the slit tangent to the disappearing limb of the sun at the beginning of totality in order to witness the reversal of the Fraunhofer lines, so admirably seen by Prof. Young in 1870, but not visible to some observers who looked for them in 1871. I proposed to look particularly for the 1474 line with the slit in this position and then to place it radially to see if the line thickened as it approached the sun's surface. The remainder of the time was to be devoted to the dark lines of the coronal spectrum and to the polariscope. I was fortunate in securing the services of Dr. Dewitt, M.D., U.S.A., to direct my telescope. During two days we practiced upon the changes and adjustments I had decided upon making during totality. By practice upon bright clouds, the sky and the moon, I decided that I could open the slit to ·1 mm. while searching for the dark lines. All previous observers had described the continuous spectrum as faint. It was therefore necessary to use a slit as wide as possible and at the same time be certain of seeing the lines. As totality approached we adjusted the slit carefully tangent to the narrow crescent of the sun. The slit plates had previously been covered with white paper to secure a distinct image of the corona at the focus of the objective. The telescope of the spectroscope was clamped so as to have the spectrum from about C to F in the field. Placing my eye at the telescope in time to get the last glimmer of the solar spectrum, I was greatly surprised an instant after at the brilliancy with which the bright lines appeared, flashing out at once to their maximum brightness. The time during which this beautiful sight lasted was not sufficient for me to positively identify the lines; yet their familiar grouping left no doubt in my mind that they occupied the places which a moment before had been occupied by the dark lines of the solar spectrum. The continuous spectrum of the sun entirely disappeared before the bright lines made their appearance. I could not estimate the number of bright lines that were in the field during the probable two seconds they were visible, but they were very numerous and the impression left upon my mind was that their brilliancy corresponded to the darkness of the same absorption bands in the solar spectrum. From its brightness and position I am confident I saw the 1474 line. When this brilliant line spectrum vanished, no lines either dark or bright were visible, but a continuous spectrum held its place. I did not notice any continuous spectrum while the lines were visible.

As previously arranged the slit was placed radially, still nothing was visible but a continuous spectrum, not bright.

The slit was at this time open ·02 mm. to which it was set before the eclipse began. The spectroscope was now rotated 90° and the slit opened to the division of the screw-head previously decided upon. The spectrum was then much brighter than I had anticipated. I directed my assistant to move the slit gradually away from the sun through the brightest part of the corona. This was done until the spectrum disappeared, when it was moved back again. The spectrum being so bright I directed the slit to be partly closed. I do not know how wide it was during the latter part of my search and omitted to examine it after the eclipse, but I estimate that it was not more than ·05 mm. The image of the corona on both sides of the sun, east and west, was caused to slowly move over the slit, yet no trace of a break in the continuous spectrum was visible. Though the spectroscope was adjusted for sharp definition of lines between C and F, I repeatedly swept over the whole length of the spectrum. I am confident that if the dark lines had approached in distinctness those of the solar spectrum they could not have escaped my attention, which was continued to the end of totality. Two minutes at least was devoted to this search. The conclusion therefore forces itself upon my mind that the light of the corona is not all reflected light. Several considerations I think lead to this conclusion. Until this eclipse no observer has ever seen the dark lines in the spectrum of the corona except M. Janssen, who reported dark lines, notably D in 1871, but much more difficult to see than the bright lines. Several observers during the recent eclipse failed to see the dark lines, though they looked for them carefully. While I do not question the results of observers who report the presence of dark lines I think all the observations taken together show that the continuous spectrum of the corona is not the spectrum of the sun. Aside from this, Prof. Arthur W. Wright made measurements of the polarization of the light of the corona, the first time I think it has been attempted, and has found the polarization to be but a small percentage of the whole light emitted. Although all reflected light does not reach us as polarized light, yet I think the small percentage of polarization taken with the faintness of the dark lines indicates that the corona is to a considerable extent self-luminous. The meteoric dust not only reflects the sun's light but it is continually showering upon the sun and in its passage through its atmosphere is rendered incandescent.

No photographs of the spectrum of the corona can probably throw any light upon the matter.

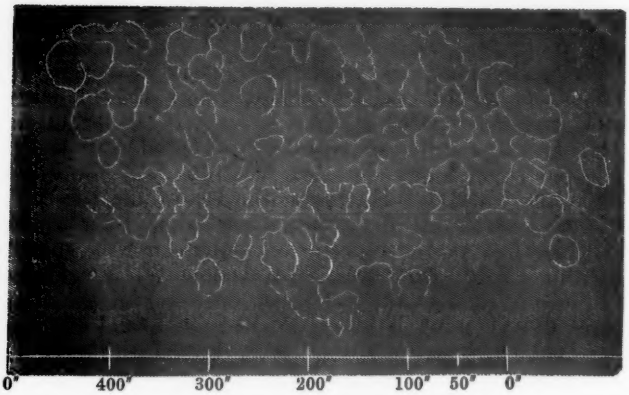
August 31, 1871.

ART. XL.—*Note on the Reticulated Forms of the Sun's Surface;* by EDWARD S. HOLDEN. Communicated by permission of Rear Admiral John Rodgers, Supt. U. S. Naval Observatory.

ON September 16 and succeeding days a watch was kept on the sun's disc, at the request of Professor Watson, for a possible transit of Vulcan.

Just before noon of September 16, Professor Eastman called my attention to certain cloud-shaped forms on the sun's disc which were visible when the sun's image, seen by projection, was allowed to move across a white screen. This was with the 9·6 inch Munich equatorial. I immediately turned the 26-inch equatorial (with aperture reduced to six inches and power 200) upon the sun and caused it to follow the sun by the driving clock. The image was thrown on a white screen about twelve inches from the focal plane and the shadows of the micrometer wires (which were placed 100″ apart) gave a scale of reference.

1.

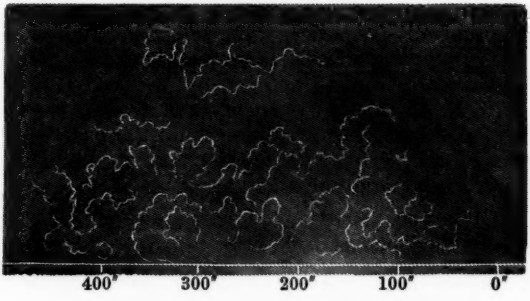


Reticulated Structure of Solar Surface.

The general mottling of the surface was not so well seen when the telescope was driven by the clock, as when the image was allowed to move across the screen. But close attention showed the whole surface to be covered by a network of dark lines 2″–3″? in thickness, each bounding an area which in general shape strongly suggested the polygonal forms photographed by Janssen and previously described and figured by Huggins and Langley. The area bounded by these lines was not seen filled by the smaller forms of Janssen. These dark lines when

seen were traced upon the screen by pencil lines and the result is shown in fig. 1. The representation is rough at best, but it has the merit of fidelity. As I was in doubt as to the meaning of my sketch and almost as to the real nature of the appearances, I enclosed it to Professor Langley and received from him the accompanying sketch, made July 25, 1873, at Allegheny, and a letter, a portion of which I quote with his kind permission.

2.



"ALLEGHENY OBSERVATORY, Allegheny, Pa., Sept. 23, 1878.

"The reticulated surface-forms, seen in good definition, occupied me at one time, and I enclose one of my early sketches reduced to the same scale as yours. In the very *best* definition I think you would find these less conspicuous—not that they are a product of poor seeing, but that an exquisite definition fills the field with details of which these seem but the aggregations. Yet it cannot be said to be absolutely sure that this obscuration of detail may not occur in the sun itself and present itself in the best seeing. I am disposed to admit the possibility of this, while holding that the change is *chiefly* from our own atmosphere. It is at any rate interesting to see how well our drawings agree in giving a certain uniformity of size to these clusters (clusters of smaller objects I take them for).

It is quite clear that there is an essential agreement here between our entirely independent sketches."

It should be mentioned that at Washington the definition was exceptionally good. The steadiness of the image I should call Wt. 4 on a scale of 5 = perfectly steady; 1 = extremely unsteady. The sky was quite clear.

It has seemed to me since receiving Professor Langley's letter that these observations should be recorded, in spite of their fragmentary character.

U. S. Naval Observatory, Oct. 1, 1878.

Art. XLI.—*Observations of Bright Meteors;* by Edwin F. Sawyer.

The following short list of meteors, equal to or exceeding first magnitude stars in brightness, have lately been recorded by me during some regular period of watching, at Cambridge, Mass. The times of apparition may be considered as accurate to within half a minute. The list is given for publication in hope that other observers may have recorded some of them, in which case interesting and valuable results can be deduced.

No. 14 was also seen and mapped by Mr. S. C. Chandler, Jr., at Marlboro, N. H., further particulars of which, together with the results deduced from others doubly observed by Mr. Chandler and the writer during the last of August, will be given in a future communication.

No.	Date. 1878.	Mean time.	Magnitude.	Observed path. From R. A.	From Dec.	to R. A.	to Dec.	Length of path.	Remarks.
		h. m.		°	°	°	°	°	
1	July 22	10 5	1	305	+58	313	+69	11+	Rapid; blue.
2	July 23	9 21	1	306	+45	312	+42	6	Quite slow; across α Cygni.
3	July 23	10 4	1	315	+ 9	318	− 1	10	Rapid.
4	July 23	10 28	1	283	+15	286	+11	5	Slow; across ε and ζ Aquilæ.
5	July 27	9 55	1	256	+56	252	+38	18	Rapid; probably a Perseid.
6	July 28	9 7	= δ	332	+56	6	+51	21	Deep red, red streak, 3 sec.
7	July 28	10 21	1	339	+33	347	+30	9	Rapid.
8	July 28	10 28	>1	346	+13	356	+32	23+	Not wholly visible; quite slow.
9	Aug. 3	9 49	1	340	+24	344	+33	10	Between η and β Pegasi, quite rapid.
10	Aug. 3	11 22	1	19	+30	22	+47	17	Slow; between β and γ Andromedæ.
11	Aug. 3	11 27	1	47	+55	50	+55	3	Rapid; a Perseid; from γ Persei.
12	Aug. 20	8 32	1	155	+72½	137½	+70	5	Slow.
13	Aug. 22	8 59	1	185	+70	170	+68	6	Rapid.
14	Aug. 22	10 2	= δ	248	+63	230	+77	15	Deep orange; orange trail; 3 sec.
15	Aug. 25	8 59	1	249½	+39	250½	+27	12	Rapid; from η Herculis.
16	Aug. 27	10 4	1	263½	+48	245	+52½	15	Rather slow; an August Lyriad.
17	Aug. 27	10 19	1	245	+56	229	+58	10	Rapid; a Lyriad.
18	Aug. 29	8 46	1	187½	+45	185½	+38½	6	Rapid.
19	Aug. 30	8 52	1	257	+50	252½	+62½	13	Slow; deep orange.
20	Aug. 31	8 35	1	212	+24	202½	+26	9	Slow; near α Boötes.
21	Sept. 1	10 8	1	236	+30	232	+22	8	Rapid; near α Coronæ.
22	Sept. 18	8 29	1	323	−15	325	−20	5	Slow; orange; orange streak.
23	Sept. 20	9 39	1	329	− 2	326	−16	14	Rapid; from near α Aquarii.
24	Sept. 22	7 19	1	289	−15	295	− 2	17	Rapid.
25	Sept. 22	8 33	>2	2½	−17½	5	−22	5	Vertically; very slow; near β Ceti. deep orange; no trail; 2 sec.
26	Sept. 23	7 18	1	355½	+12½	346	− 6½	15	Rapid.
27	Sept. 23	8 25	1	360	+28	10	+26	10	2 sec.; green.
28	Sept. 23	9 26	>1	42	+56	105	+65	33	Slow; visible 2 sec.; blue.
29	Sept. 27	8 10	1	341½	+16	347	+22	7	Very slow; 1·5 sec.; orange.
30	Sept. 28	9 52	1	49	+ 8	47	− 2	10	Rapid; green.
31	Sept. 29	9 5	1	15	+ 3				Stationary; 1 sec.; approximate.
32	Sept. 29	9 36	1	48	+21	55	+17½	8	Rapid.

ART. XLII.—*Remarks on the General Ocean Circulation;* by SIR WYVILLE THOMSON. From his Address to the Geographical Section of the British Association, at its recent meeting.*

IT was pointed out long ago by Sir Charles Lyell that many of the most marked phenomena of the present physical condition of the globe depend upon the fact that the surface of the world is divided into two hemispheres, one of which contains nearly the whole of the dry land of this world, while the other is almost entirely covered by water. The center of the land hemisphere is somewhere in Great Britain, and the center of the water hemisphere, which includes the southern sea, the South Pacific, whatever antarctic land there may be, Australia, and the southern point of South America, is in this neighborhood of New Zealand. With a full knowledge of the absolute continuity of the ocean we have hitherto been too much in the habit of regarding it as composed of several oceans, each possibly under special physical conditions. All recent observations have, however, shown us that the vast expanse of water which has its center in the southern hemisphere is the one great ocean of the world, of which the Atlantic with the Arctic Sea and the North Pacific are merely northward extending gulfs; and that any physical phenomena affecting obviously one portion of its area must be regarded as one of an interdependent system of phenomena affecting the ocean as a whole.

Shallow as the stratum of water forming the ocean is—a mere film in proportion to the radius of the earth—it is very definitely split up into two layers, which, so far as all questions concerning ocean movements and the distribution of temperature are concerned, are under very different conditions. At a depth varying in different parts of the world, but averaging perhaps 500 fathoms, we arrive at a layer of water at a temperature of 40° F., and this may be regarded as a kind of neutral band separating the two layers. Above this band the temperature varies greatly over different areas, the isothermobathic lines are sometimes tolerably equally distributed, and at other times crowding together towards the surface, while beneath it the temperature almost universally sinks very slowly and with increasing slowness to a minimum at the bottom.

The cause of natural phenomena, such as the movements of great masses of water, or the existence over large areas of abnormal temperature conditions, are always more or less complex, but in almost all cases one cause appears to be so very much the most efficient that in taking a general view all others

* Nature, August 22, 1878.

may be practically disregarded: and speaking in this sense it may be said that the trade-winds and their modifications and counter-currents are the cause of all movements in the stratum of the ocean above the neutral layer. This system of horizontal circulation, although so enormously important in its influences upon the distribution of climate is sufficiently simple. Disregarding minor details, the great equatorial current driven from east to west across the northerly extensions of the ocean by the trade-winds, impinges upon the eastern coasts of the continents. A branch turns northward and circles round the closed end of the Pacific, tending to curl back to the North American coast from its excess of initial velocity; and in the Atlantic, following a corresponding course, the Gulf Stream bathes the shores of Northern Europe, and a branch of it forces its way into the Arctic basin, and battling against the palæocrystic ice, keeps imperfectly open the water-way by which Nordenskjöld hopes to work his course to Behring's Strait. The southern deflections are practically lost, being to a great extent, though not entirely dissipated in the great westerly current of the southern anti-trades.

One of the most singular results of these later investigations is the establishment of the fact that all the vast mass of water, often upwards of 2,000 fathoms in thickness, below the neutral band, is moving slowly to the northward; that in fact the depths of the Atlantic, the Pacific and the Indian Oceans are occupied by tongues of the Antarctic Sea, preserving in the main its characteristic temperatures. The maintenance of a low temperature while the temperature of the floor of the ocean must be higher, and that of the upper layers of the sea greatly higher, is in itself a conclusive proof of steady movement of the water from a cold source; and the fact that the temperature of the lower layers of water, both in the Atlantic and the Pacific, is slightly but perceptibly raised to the northward, while the continuity of every layer with a corresponding layer in the southern sea can be clearly traced, indicates the southern position of that source.

The immediate explanation of this very unexpected phenomenon seems simple. For some cause or other, as yet not fully understood, evaporation is greatly in excess of precipitation over the northern portion of the land-hemisphere, while over the water-hemisphere, and particularly over its southern portion, the reverse is the case; thus one part of the general circulation of the ocean is carried on through the atmosphere, the water being raised in vapor in the northern hemisphere, hurried by upper wind currents to the zone of low barometric pressure in the south, where it is precipitated in the form of snow or rain, and welling thence northward in the deepest channels on

account of the high specific gravity dependent on its low temperature, it supplies the place of the water which has been removed.

The cold water wells northward, but it meets with some obstructions on its way, and these obstructions, while they prove the northward movement, if further proof were needed, bring out another law by which the distribution of ocean temperature is regulated. The deeper water sinks slowly to a minimum at the bottom, so that if we suppose the temperature at a depth of 2,000 fathoms to be 36° F., the temperature at a depth of 3,000 may be, say, 32°. Now, if in this case the slow current meet on its northward path a continuous barrier in the form of a submarine mountain ridge rising to within 2,000 fathoms of the sea-surface, it is clear that all the water below a temperature of 36° will be arrested, and, however deep the basin beyond the ridge may be, the water will maintain a minimum of 36° from a depth of 2,000 fathoms to the bottom. In many parts of the ocean we have most remarkable examples of the effect upon deep-sea temperature of such barriers intersecting cold indraughts, the most marked instance, perhaps, a singular chain of closed seas at different temperatures among the islands of the Malay Archipelago; but we have also a striking instance nearer home. Evaporation is greatly in excess of precipitation over the area of the Mediterranean, and consequently, in order to keep up the supply of water to the Mediterranean, there is a constant inward current through the Straits of Gibraltar from the Atlantic; I need not at present refer to an occasional tidal counter-current. The minimum temperature of the Mediterranean is about 54° F. from a depth of 100 fathoms to the bottom. The temperature of 54° is reached in the Atlantic at the mouth of the Straits of Gibraltar at a depth of about 100 fathoms, so that in all probability future soundings will show that the free water-way through the Straits does not greatly exceed 100 fathoms in depth.

The Depth of the Sea, and the Nature of Modern Deposits.—It seems now to be thoroughly established by lines of trustworthy soundings which have been run in all directions, that the average depth of the ocean is a little over 2,000 fathoms, and that in all probability it nowhere exceeds 5,000 fathoms. Depths beyond 4,000 fathoms are rare and very local, and seem to be usually pits in the neighborhood of volcanic islands. In all the ocean basins there are depressions extending over considerable areas where the depth reaches 3,000 fathoms or a little more, and these depressions maintain a certain parallelism with the axes of the neighboring continents.

Within 300 or 400 miles of the shore, whether in deep or in shallow water, formations are being laid down, whose materials

are derived mainly from the disintegration of shore rocks, and which consequently depend for their structure and composition upon the nature and composition of the rocks which supply their materials. These deposits imbed the hard parts of the animals living on their area of deposition, and they correspond in every way with sedimentary formations with which we are familiar, of every age. In water of medium depths down to about 2,000 fathoms, we have in most seas a deposit of the now well-known globigerina-ooze, formed almost entirely of the shells of foraminifera living on the sea-surface, and which after death have sunk to the bottom. This formation, which occupies a large part of the bed of the Atlantic and a considerable part of that of the Pacific and Southern Seas, is very like chalk in most respects, although we are now satisfied that it is being laid down as a rule in deeper water than the chalk of the Cretaceous period.

In depths beyond 2,500 or 3,000 fathoms no such accumulations are taking place. The shores of continents are usually too distant to supply land detritus, and although the chalk-building foraminifera are as abundant on the surface as they are elsewhere, not a shell reaches the bottom; the carbonate of lime is entirely dissolved by the carbonic acid contained in the water during the long descent of the shells from the surface. It therefore becomes a matter of very great interest to determine what processes are going on, and what kind of formations are being laid down in these abyssal regions, which must at present occupy an area of not less than ten millions of square miles.

The tube of the sounding instrument comes up from such abysses filled with an extremely fine reddish clay, in great part amorphous, but containing, when examined under the microscope, a quantity of distinctly recognizable particles, organic and inorganic. The organic particles are chiefly siliceous, and for the most part the shells or spines of radiolarians which are living abundantly on the surface of the sea, and apparently in more or less abundance at all depths. The inorganic particles are minute flakes of disintegrated pumice, and small crystalline fragments of volcanic minerals; the amorphous residue is probably principally due to the decomposition of volcanic products, and partly to the ultimate inorganic residue of decomposed organisms. There is ample evidence that this abyssal deposit is taking place with extreme slowness. Over its whole area, and more particularly in the deep water of the Pacific, the dredge or trawl brings up in large numbers nodules very irregular in shape, consisting chiefly of sesquioxide of iron and peroxide of manganese, deposited in concentric layers in a matrix of clay, round a nucleus formed of a shark's tooth, or a piece of

bone, or an otolith, or a piece of siliceous sponge, or more frequently a fragment of pumice. These nodules are evidently formed in the clay, and the formation of the larger ones and the segregation of their material must have taken a very long time. Many of the sharks' teeth to which I have alluded as forming the nuclei of the nodules, and which are frequently brought up uncoated with foreign matter, belong to species which we have every reason to believe to be extinct. Some teeth of a species of *Carcharodon* are of enormous size, four inches across the base, and are scarcely distinguishable from the huge teeth from the Tertiary beds of Malta. It is evident that these semi-fossil teeth, from their being caught up in numbers by the loaded line of the trawl, are covered by only a very thin layer of clay.

Another element in the red clay has caused great speculation and interest. If a magnet be drawn through a quantity of the fine clay well diffused in water, it will be found to have caught on its surface some very minute magnetic spherules, some apparently of metallic iron in a passive state, and some of metallic nickel. From the appearance of these particles, and from the circumstance that such magnetic dust has been already detected in the sediment of snow-water, my colleague Mr. Murray has a very strong opinion that they are of cosmic origin—excessively minute meteorites. They certainly resemble very closely the fine granules which frequently roughen the surface of the characteristic skin of meteorites, and from their composition and the circumstances under which they are found there is much to be said in favor of this view. I cannot, however, hold it entirely proved; there can be little doubt, from the universal presence of water-logged and partially decomposed pumice on the bottom, and from the constant occurrence of particles of volcanic minerals in the clay, that the red clay is formed in a great measure by the decomposition of the lighter products of submarine volcanoes drifted about by currents, and finally becoming saturated with water and sinking; and it is well known that both iron and nickel in a metallic state are frequently present in minute quantities in igneous rocks. I think it is conceivable that the metallic spherules may be derived from this source.

So far as we can judge, after a most careful comparative examination, the deposit which is at present being formed at extreme depths in the ocean does not correspond, either in structure or in chemical composition, with any known geological formation; and, moreover, we are inclined to believe, from a consideration of their structure and of their imbedded organic remains, that none of the older formations were laid down at nearly so great depths—that, in fact, none of these have any-

thing of an abyssal character. These late researches tend to show that during past geological changes abyssal beds have never been exposed, and it seems highly probable that until comparatively recent geological periods such beds have not been formed.

It appears now to be a very generally received opinion among geologists—an opinion which was first brought into prominence by Professor Dana—that the "massive" eruptions which originated the mountain chains which form the skeleton of our present continents, and the depressions occupied by our present seas date from the secular cooling and contraction of the crust of the earth—from a period much more remote than the deposition of the earliest of the fossiliferous rocks—and that during the period chronicled by the successive sedimentary systems, with many minor oscillations by which limited areas have been alternately elevated and depressed, the broad result has been the growth by successive steps of the original mountain chains and the extension of the continents by their denudation, and the corresponding deepening of the original grooves. If this view be correct—and it certainly appears to me that the reasoning in its favor is very cogent—it is quite possible that until comparatively recent times no part of the ocean was sufficiently deep for the formation of a characteristic abyssal deposit.

Time will not allow me even to allude to the interesting results which have been obtained from the determination of the density of sea water from different localities and different depths, and from the analysis of sea water and its contained gases, and perhaps these results have been scarcely sufficiently worked out as yet to afford safe bases for generalization. I must, however, say a few words as to certain additions which have been made to our knowledge of the two hitherto impregnable strongholds of the frost, the regions round the North and South Poles.

The Arctic Regions.—The question which has of late held the most prominent place in all discussions about the conditions of the Arctic Regions, particularly since the voyage of Dr. Hayes, is whether it is possible that there can be, at all times or at any time, anything in the form of an open Polar sea. This question seems now to be virtually settled, and in the most unsatisfactory manner imaginable. There can be no doubt that in the year 1871 Count Wilczek, in the schooner *Isbjörn*, found the sea between Novaya Zemlya and Spitzbergen nearly free from ice, and that the same sea presented to Weyprecht and Payer in the following year a dangerous stretch of moving and impenetrable pack. There can be no doubt that in the year 1861 Dr. Hayes gazed over an expanse of open water where, in 1875–76, Capt. Nares studied the conditions of palæocrystic ice. It is evident, therefore, that the Polar basin, or at all events

such portions of it as have been hitherto reached, is neither open sea nor continuous ice, but a fatal compromise between the two, an enormously heavy pack formed by the piling up and crushing together of the floe of successive years, in frequent movement, breaking up and shifting according to the prevailing direction of the wind, and leaving open, now here and now there, lanes and vistas of deceptive open water which may be at any moment closed and converted into a chaotic mass of hurling floe-bergs by a hurricane from another direction. It seems, however, that in certain seasons there is more open water in the direction of Grinnell's Land and Smith's Sound than in others, and that there are also years comparatively favorable for the northward route following the lead of Franz-Josef Land; and there seem now to be only two plans, one nearly as hopeless as the other, to choose between in any future attempt—either to establish several permanent Polar stations, as proposed by Lieut. Weyprecht, and already initiated at one point, so far as preliminaries are concerned, by Capt. Tyson and Capt. Howgate, and to seize the opportunity of running north in early autumn from the station where the sea appears most open, or to run as far north as possible at enormous expense, with a great force of men and abundance of provisions and paraffin oil, and push northward during the arctic winter by a chain of communicating stations with ice-built refuge huts. It seems possible that in a cold season, with the pack in the condition in which Markham found it in 1876, some progress might be made in this way if it were conceivable that the end to be gained was worth the expenditure of so much labor and treasure.

The Antarctic Regions.—But little progress has been made during the last quarter of a century in the actual investigation of the conditions of that vast region which lies within the parallel of 70° S. Some additional knowledge has been acquired, and the light which recent inquiries have thrown upon the general plan of ocean circulation and the physical properties of ice, have given a new direction to what must partake for some time to come of the nature of speculation.

From information derived from all sources up to the present time, it may be gathered that the unpenetrated area of about 4,700,000 square miles surrounding the South Pole is by no means certainly a continuous "Antarctic Continent," but that it consists much more probably partly of comparatively low continental land, and partly of a congeries of continental (not oceanic) islands, bridged between and combined, and covered to the depth of about 1,400 feet, by a continuous ice-cap; with here and there somewhat elevated continental chains, such as the groups of land between 55° and 95° W., including Peter

the Great Island and Alexander Land, discovered by Billingshausen in 1821, Graham Land and Adelaide Island, discovered by Biscol in 1832, and Louis Philippe Land by D'Urville in 1838, and at least one majestic modern volcanic range discovered by Ross in 1841 and 1842, stretching from Balleny Island to a latitude of 78° S., and rising to a height of 15,000 feet. It seems, so far as is at present known, that the whole of the antarctic land, low and high, as well as the ice-cap of which a portion of the continuous continent may consist, is bordered to some distance by a fringe of ice, which is bounded to seaward by a perpendicular ice-cliff, averaging 230 feet in height above the sea-level. Outside the cliff a *floe*, which attains near the barrier a thickness of about twenty feet, and in some places by piling a considerably greater thickness, extends northward in winter to a distance varying according to its position with reference to the southward trending branches of the equatorial current; and this floe is replaced in summer by a heavy drifting pack with scattered icebergs. Navigating the Antarctic Sea in the southern summer, the only season when such navigation is possible, it has been the opinion of almost all explorers, that after forcing a passage through an outer belt of heavy pack and icebergs, moving as a rule to the northwestward, and thus fanning out from the ice-cliff in obedience to the prevailing southeasterly winds, a band of comparatively clear water is to be found within.

Several considerations appear to me to be in favor of the view that the area round the South Pole is broken up and not continuous land. For example, if we look at a general ice-chart we find that the sea is comparatively free from icebergs, and that the deepest notches occur in the "Antarctic Continent" at three points, each a little to the eastward of south of one of the great land masses. Opposite each of these notches a branch of the equatorial current is deflected southward by the land, and is almost merged in the great drift-current which sweeps round the world in the Southern Sea before the westerly anti-trades. But while the greater portion of the Brazilian current, the East Australian current, and the southern part of the Agulhas current are thus merged, they are not entirely lost; for at these points of junction with the drift-current of the westerlies, the isobathytherms are slightly deflected to the southward, and it is opposite these points of junction that we have comparatively open sea and penetrable notches in the southern pack. But we have not only the presumed *effect* of this transfer of warmer water to the southward; we were able to detect its presence in the *Challenger* by the thermometer. Referring to the result of a serial temperature sounding on February 14, 1874, with a surface temperature of 29° F. at a

depth of from 300 to 400 fathoms, there is a band of water at a temperature of more than half a degree above the freezing-point. That this comparatively warm water is coming from the north there is ample proof. We traced its continuity with a band at the same depth gradually increasing in warmth to the northward, and it is evident that its heat can be derived from no other source, and that it must be continually receiving new supplies, for it is overlaid by a band of colder water, tending to mix with it by convection.

It is, of course, possible that these warm currents may by coincidence be directed toward those notches already existing in a continental mass of land; but such a coincidence would be remarkable, and there is certainly a suggestion of the alternative that the "continent" may consist to so great an extent of ice as to be liable to have its outline affected by warm currents.

In high southern latitudes it seems that all the icebergs are originally tabular, the surface perfectly level and parallel with the surface of the sea, a cliff about 230 feet high bounding the berg. The top is covered with a layer of the whitest snow; now and then a small flock of petrels take up their quarters upon it, and trample and soil some few square yards, but after their departure one of the frequent snow showers restores it in a few minutes to its virgin whiteness. The upper part of the cliff is pale blue, which gradually deepens toward the base. When looked at closely the face of the cliff is seen to be traversed by a delicate ruling of faint blue lines, the lines being more distant from one another above and becoming gradually closer. The distance between the well-marked lines near the top of a berg may be of a foot or even more, while near the surface of the water it is not more than two or three inches, and the space between the blue lines have lost their dead whiteness and have become hyaline or bluish. The blue lines are very unequal in their strength and in their depth of coloring; sometimes a group of very dark lines gives a marked character to a part of a berg. Between the stronger blue lines near the top of the cliff a system of closer lines may be observed, marking the division of the ice by still finer planes of lamination; but in the narrower spaces near the water-line they are blended and lost. The blue lines are the sections of sheets of clear ice; the white intervening bands are the sections of layers of ice where the particles are not in such close contact —ice probably containing some air.

The stratification in all these icebergs is, I believe, originally horizontal and conformable, or very nearly so. In many, while melting and beating about in the sea, the strata become inclined at various angles, or vertical or even reversed; in many they are traversed by faults, or twisted, or contorted, or displaced;

but I believe that all deviations from a horizontal arrangement are due to changes taking place in the icebergs themselves.

I think there can be no doubt, from their shape and form, and their remarkable uniformity of character, that these great table-topped icebergs are prismatic blocks riven from the edge of the great antarctic ice-sheet. I conclude, therefore, that the upper part of the iceberg, including by far the greater part of its bulk, and culminating in the portion exposed above the surface of the sea, was formed by the piling up of successive layers of snow during the period, amounting perhaps to centuries, during which the ice-cap was slowly forcing its way over the low land, and out to sea over a long extent of gentle slope, until it reached a depth considerably beyond 200 fathoms, when the lower specific weight of the ice caused an upward strain which at length overcame the cohesion of the mass, and portions were rent off and floated away. The icebergs when they are first dispersed float in from 200 to 250 fathoms; when, therefore, they have been drifted to latitudes of 65° or 64° south, the bottom of the berg, the surface which forced itself glacier-like over the land, just reaches the layer at which the temperature of the water distinctly rises; and is rapidly melted, and the pebbles and land *débris* with which it is more or less charged are precipitated. That this precipitation takes place all over the area where the icebergs are breaking up, constantly and to a considerable extent, is evident from the fact that the matter brought up by the sounding instrument and the dredge is entirely composed of such deposits from ice; for diatoms, foraminifera and radiolarians are present on the surface in large numbers, and unless the deposit from the ice were abundant it would soon be covered and masked by the skeletons of surface organisms.

The curious question now arises, what is the cause of the uniform height of the southern icebergs—that is to say, what is the cause of the restriction of the thickness of the free edge of the ice-cap to 1,400 fathoms? I have mentioned the gradual diminution in thickness of the strata of ice in a berg from above downward. The regularity of this diminution leaves it almost without a doubt that the layers observed are in the same category, and that therefore the diminution is due to subsequent pressure or other action upon a series of beds, which were at the time of their deposition nearly equally thick. About 60 or 80 feet from the top of an iceberg, the strata of ice a foot or so in thickness, although of a white color and thus indicating that they contain a considerable quantity of air, are very hard, and the specific weight of the ice is not much lower than that of layers three inches thick nearer the water-line of the berg. The upper layers have been manifestly produced by falls of snow after the berg has been detached.

Now it seems to me that the reduction in thickness cannot be due to compression alone, but that a portion of the substance of the lower layers must have been removed. It is not easy to see why the temperature of the earth's crust, under a widely extended and practically permanent ice-sheet of great thickness, should ever fall below the freezing-point; and it is a matter of observation that at all seasons of the year vast rivers of muddy water flow into the frozen sea from beneath the great glaciers which are the issues of the ice-sheet of Greenland. Ice is a very bad conductor, so that the cold of winter cannot penetrate to any great depth into the mass. The normal temperature of the surface of the earth's crust, at any point where it is uninfluenced by cyclical changes, is at all events above the freezing-point, so that the temperature of the floor of the ice-sheet would certainly have no tendency and fall below that of the stream passing over it. The pressure upon the deeper beds of the ice must be enormous at the bottom of an ice-sheet 1,400 feet in thickness—not much less than a quarter of a ton on the square inch. It seems, therefore, probable that under the pressure to which the body of ice is subjected a constant system of melting and regelation is taking place, the water passing down by gravitation from layer to layer until it reaches the floor of the ice-sheet, and finally working out channels for itself between the ice and the land, whether the latter be subærial or submerged.

I should think it probable that this process, or some modification of it, may be the provision by which the indefinite accumulation of ice over the antarctic continent is prevented and a certain uniformity in the thickness of the ice-sheet maintained—that in fact ice at the temperature at which it is in contact with the surface of the earth's crust within the antarctic regions cannot support a column of itself more than 1,400 feet high without melting. It is suggested to me by Professor Tait that the thickness of the ice-sheet very probably depends upon its area, as the amount of melting through squeezing and the earth's internal heat, will depend upon the facility of the escape of the water. The problem is, however, an exceedingly complex one, and we have perhaps scarcely sufficient data for working it out.

The Fauna of the Deep Sea.—I can scarcely regret that it is utterly impossible for me on this occasion to enter into any details with regard to the relations of the abyssal fauna, the department of the subject which has naturally had for me the greatest interest. Recent investigations have shown that there is no depth limit to the distribution of any group of gill-bearing marine animals. Fishes, which, from their structure and from what we know of the habits of their congeners, must certainly

live on the bottom, have come up from all depths, and at all depths the whole of the marine invertebrate classes are more or less fully represented. The abyssal fauna is of a somewhat special character, differing from the fauna of shallower water in the relative proportions in which the different invertebrate types are represented. It is very uniform over an enormously extended area, and in this respect it fully confirms the anticipations of the great Scandinavian naturalist, Lovén, communicated to this Association in the year 1844. It is a rich fauna, including many special genera and an enormous number of special species, of which we, of course, know as yet only a fraction; but I do not think I am going too far in saying that from the results of the *Challenger* expedition alone the number of known species in certain classes will be doubled. The relations of the abyssal fauna to the faunæ of the older Tertiary and the newer Mesozoic periods are much closer than are those of the faunæ of shallow water; I must admit, however, that these relations are not so close as I expected them to be—that hitherto we have found living only a very few representatives of groups which had been supposed to be extinct. I feel, however, that until the zoological results of these later voyages, and especially those of the *Challenger*, shall have been fully worked out, it would be premature to commit myself to any generalizations.

I have thus attempted to give a brief outline of certain defensible general conclusions, based upon the results of recent research. Some years ago, certain commercial enterprises, involving the laying of telegraph cables over the bed of the sea, proved that the extreme depths of the ocean were not inaccessible. This somewhat unexpected experience soon resulted in many attempts, on the part of those interested in the extension of the boundaries of knowledge, to use what machinery they then possessed to determine the condition of the hitherto unknown region. This first step was naturally followed by a development of all appliances and methods bearing upon the special line of research; and within the last decade the advance of knowledge of all matters bearing upon the physical geography of the sea has been confusingly rapid—so much so, that at this moment the accumulation of new material has far outstripped the power of combining and digesting and methodizing it. This difficulty is greatly increased by the extreme complexity of the questions, both physical and geological, which have arisen. Steady progress is, however, being made in both directions, and I trust that in a few years our ideas as to the condition of the depth of the sea may be as definite as they are with regard to regions to which we have long had ready access.

ART. XLIII.—*Notes on Antimony Tannate.* No. II; by ELLEN SWALLOW RICHARDS and ALICE W. PALMER.

THE next point of interest was to determine whether the method of titration as given in the preceding paper (this Journal, p. 196) was applicable to tannin-holding substances other than nut-galls and sumac. The following tests were made for this purpose:

	Tannin. Per cent.
Leaves of sweet-fern (*Comptonia asplenifolia*) from near Boston, gathered the middle of May	7·56
The same, gathered on the Kennebec River, Maine, the last of July	8·00
Sample of ground hemlock-bark from Vermont	7·07
Sample of catechu	29·70
Sample of kino	41·50
Crushed quercitron bark	7·00
Congo tea	4·60
Cinchona flavor	9·60
Ground cloves	7·03
Chestnut-oak from Careyville, Tenn.	3·00

We also prepared a quantity of antimony-tannate from each of these substances in the same manner as we had prepared it from commercial tannin and sumac. The composition is given as follows:

	Sb. Per cent.	C. Per cent.	H. Per cent.
Sweet-fern (May)	15·30	45·09	3·40
Sweet-fern (July)	15·06	44·90	3·90
Quercitron	12·80	49·50	3·42
Chestnut-oak	15·50	47·51	3·63
Cloves	12·50	43·30	3·09
Hemlock-bark, No. I.	13·60	51·02	3·85
Hemlock-bark, No. II.	13·50	49·86	
Catechu	13·70	51·13	3·84
Kino	15·00	50·71	3·72
Cinchona flava	11·20	53·56	4·56
Congo tea	11·40	47·30	4·00

These analyses showed that the composition of the precipitate was influenced by one of two causes: either the formula of the so-called tannin which united with the antimony contained more C and H than di-gallic acid,—that is, it must be something like $SbOC_{38}H_{33}O_{17}$ or $Sb_2(C_{25}H_{21}O_{12})_3$—or the antimony-tannate, which was formed in the solution, acted as a mordant, and carried down with it coloring matters which might or might not affect the titration, but which did affect the combustion.

To determine how far this latter cause could be held responsible, we prepared antimony tannate from the sample of tannin

which we used for all our experiments, and having washed by decantation so as to keep the gelatinous precipitate in the best condition for absorbing color, we treated solutions of several of these substances with a quantity of antimony tannate corresponding to the estimated quantity of tannin contained in the solution, so as to have the conditions the same as in the previous precipitations; in one case we increased the amount of antimony tannate. The composition of the antimony tannate thus treated in the different solutions, together with the average composition of antimony tannate as we have already obtained it from tannin, sumac and nut-galls is given as follows:

	Sb. Per cent.	C. Per cent.	H. Per cent.
Sweet-fern + antimony tannate	15·70	46·21	3·73
Quercitron + antimony tannate	9·54	45·90	3·80
Hemlock + antimony tannate		63·30	3·60
Hemlock + five times the required amount of antimony tannate	13·40	43·40	3·90
Antimony-tannate	20·00	38·21	2·86

In the case of sweet-fern and quercitron, the results are very nearly those obtained by direct precipitation with tartar emetic. The possible reason for this will be considered later.

We were greatly surprised by the behavior of the solution of hemlock-bark. In all cases after treating the solution with the previously prepared antimony-tannate, we precipitated the remaining tannin by tartar emetic as usual, and noted the quantity required as compared with that required for the precipitation of tannin in the titration. The sweet-fern and quercitron gave a precipitate about one-third less than that from the original solution. In the case of hemlock there was scarcely a trace of a precipitate, showing that the antimony tannate had dragged down or united with all the substance which had been supposed to be tannin.

In order further to test the character of the supposed coloring matter in these substances, we made a series of trials with mordanted yarn. A brown-red color was obtained from hemlock on wool mordanted with tin chloride, and on cotton mordanted with alumina. A brilliant yellow color nearly equal to that from quercitron was obtained from sweet-fern on both the wool and the cotton.

We then tested solutions of all the substances upon which we had been working with cloth mordanted in the usual way for calico-printing (with iron and alumina in alternate stripes), in order to show the presence of tannin and coloring matter at the same time. This test divided the substances into two classes, the one showing the deep black of tannin on the iron stripe, and a yellow more or less intense on the alumina; the other giving on the iron stripe a faint brownish-black, corre-

sponding in dullness to that produced by gallic acid, and on the alumina a dull reddish-brown. To the first class belong nut-galls, sumac, sweet-fern leaves, bark of quercitron, black oak, white oak and chestnut oak and bearberry leaves; to the other, hemlock, catechu, kino, fever bark, cinchona bark and congo tea. For our further investigation we took sweet-fern as the type of the former, and hemlock as that of the latter class.

The yellow in sweet-fern seems closely allied to, if not identical with the quercetin derived from oak-bark. A solution of sweet-fern guarancined (i. e., boiled with very dilute sulphuric acid), behaves like a solution of quercitron-bark,—a black gummy mass being formed, and the solution depositing yellow flakes which dye intensively.

Two pieces of cloth of equal size, the one dyed with one gram of sweet-fern leaves, the other with one gram of quercitron-bark, showed rather more tannin and less yellow for the sweet-fern, and more yellow and less tannin for the quercitron.

A single trial of the amount of yellow in sweet-fern, by weighing the antimony-tannate which had carried down the yellow with it, and which had been added in known quantity gave 2·5 per cent, and the amount of tannin in the filtrate had decreased about three of the eight per cent. This indicates that the antimony combines with a portion of the coloring matter, as well as with the tannin. This is further shown by the fact that the quercetin-like color obtained by guarancining was precipitated by antimony. The formula of this portion of the color must be very near to that of di-gallic acid, since the per cent of C and H in the precipitate from sweet-fern after the original solution had been treated with antimony tannate and the tannin then precipitated by tartar emetic was C 44·32 and H 3·39, and the composition of the precipitate when tartar emetic had been added directly to the solution without previous treatment with the antimony tannate was C 44·9 per cent and H 3·9 per cent.

Heppe (Die chemischen Reactionen) gives the formula of quercetin as $C_{27}H_{18}O_{12}$ and that of quercetin acid as $C_{15}H_{10}O_7$, which, corresponding to our formula of antimony tannate, would give respectively:

	Sb.	C.	H.
$Sb_2(C_{27}H_{19}O_{13})_2+6H_2O$	12·52 pr. ct.	50·00	3·08
$Sb_2(C_{15}H_8O_7)_2+6H_2O$	19·49	43·13	2·87
Antimony-tannate,			
$Sb_2(C_{14}H_8O_9)_2+6H_2O$	18·59	38·41	2·74

The result of this is that the process of titration with tartar emetic, when applied to the class of substances holding this yellow coloring principle, would give too high results. We

have not yet succeeded in isolating this yellow coloring matter unchanged, in order to test its effect on the accuracy of the iodine process or Löwenthal's method.

As to the brown-red obtained from the fresh hemlock, it seems to belong to a different class of substances. It is precipitated by gelatine, is acted on by iodine, is precipitated by antimony, and on fusion with potassium hydrate it is decomposed, and a substance is formed which blackens the iron stripe like tannin. We have not yet obtained a sufficient quantity to determine its composition or to deduce a theory for its relation to di-gallic acid. Our experiments go to show that the red-brown is decomposed in the slow process of fermentation, and the iron-blackening substance thus formed may possibly be the agent of the tanning.

Massachusetts Institute of Technology, Woman's Laboratory, August, 1878.

ART. XLIV.—*On a Pseudomorph after Anorthite, from Franklin, New Jersey;* by Professor W. T. RŒPPER.

ON the northern part of Mine Hill, at Franklin, New Jersey, there are found, partly in detached pieces scattered over the surface, or in the fences surrounding the fields of the miners, and in place in a stratum of white crystalline limestone, pseudomorphs that have the form of anorthite, accompanied by a dark hornblende, and numerous small, very brilliant and highly modified, clove-brown crystals of sphene. The outside of the anorthite crystals, the larger of which are generally more or less cavernous, is invariably "candied" over by exceedingly small, brilliant prismatic crystals.

The crystals, from one-eighth to two or three inches in size, are distinctly feldspathic in habit, the prevailing faces, in the order of their dominancy, being: *O*, *i*-$\breve{i}$, *I*, 2-$\breve{i}$, 2-$\bar{i}$ and 1. Owing to the above mentioned micro-crystalline character of the surface and consequent want of reflection, the angles can be measured only with the application-goniometer. The following angles are averages of a number of tolerably concordant measurements:

O ∧ *i*-$\breve{i}$ over 2-$\breve{i}$	¾	85°	33′,	difference of extremes,	20′
O ∧ I′	¾	114	32,	" "	12′
O ∧ I	⅗	110	32,	" "	5′
O ∧ 2-$\bar{i}$	½	98	56,	" "	40′
I ∧ I′		120	50,		
O ∧ 2′-$\breve{i}$		133	10,		
O ∧ 1		122			

O ∧ *i*-$\breve{i}$ however is in some crystals as high as 88°. Cleavage O and *i*-$\bar{i}$ easy and distinct, generally dull, but the basal cleavage occasionally sub-pearly.

H.=6; G.=3·06–3·10. Color light bluish green to greenish white.

Fusible with some difficulty to a slightly vesicular glass. Partially attacked by hydrochloric acid without gelatinizing.

				Oxygen.	
Composition:	Silica	39·73		21·19	4
	Alumina	32·53	15·16	16·00	3
	Iron sesquioxide	2·80	·84		
	Magnesia	1·44	·57		
	Lime	14·93	4·27	5·80	1
	Soda	·43	·11		
	Potash	5·01	·85		
	Ignition	3·65			
		100·52			

I have to remark that I have reason to consider the magnesia too high. There is probably only a trace. If so, the oxygen ratio would be 21·19 : 16 : 5·23, still nearer the anorthite ratio of 4 : 3 : 1.

Though the crystalline form and the composition would make it a lime-potash anorthite, the high specific gravity and the water point to a change or alteration of its original constitution. The nature of this change is clearly shown by a thin section, which Mr. G. W. Hawes was so kind as to make for me. When observed under the microscope, it shows that the mineral is composed of a congeries of small crystals, which produce no change of color under the revolution of the polarizer. The change seems therefore to consist in an internal molecular re-arrangement of part of the constituents of the original anorthite, with the introduction of potash and of some water, whereby its specific gravity was raised to the above-mentioned figure. The minute crystals coating the pseudomorphs may possibly be the actual crystals of the new mineral, which on the surface were able to develop their form. What the latter actually are it is impossible to determine.*

Bethlehem, Pa., Sept. 16, 1878.

* In the Report of Mr. G. W. Hawes on the "Mineralogy and Lithology of New Hampshire," its author gives the following analysis of altered crystals of anorthite of large size, from "diabase," at East Hanover, in that State: Silica 52·52, alumina 30·05, iron sesquioxide 1·10, magnesia 0·30, lime 2·20, soda 3·77, potash 7·11, water 2·67=99·72; G.=2·96. It is a potash-bearing pseudomorph, like that described by Rœpper, with similarly high specific gravity; but instead of having the removed calcium replaced by an *equivalent* proportion of alkali metals, so that the anorthite ratio remains, there is a large loss, as Mr. Hawes states. He recognizes a relation in density to the saussurites. But while this is right, both of these pseudomorphs are removed from the saussurites of euphotide, hitherto studied, by being potash species. The above analysis gives the quantivalent ratio for the protoxides, sesquioxides, and silica, 1 : 5 : 9·5; or, if the water is included in the protoxides, 1 : 2·7 : 5·3. J. D. D.

ART. XLV.—*Upon the Relative Agency of Glaciers and Sub-Glacial Streams in the Erosion of Valleys;** by Professor W. H. NILES.

IN some remarks† which I made at a meeting of this Society in April, 1873, I stated that my observations among the glaciers of the Alps during the previous summer had led me to the conclusion "that glaciers were not the principal agents in the excavation of valleys." I have since had the opportunity of spending two summers more among those glaciers, and the observations which I made have not only confirmed my previous conclusion, but they have also furnished me additional evidences of the excavating power of sub-glacial streams. This time I was more successful in getting underneath the ice than before, particularly upon the right side of the Great Aletsch Glacier where it passes the cliff near the Bell Alp Hotel. The way glaciers usually move over the ordinary *roches moutonnées*, bridging the hollows between them without conforming to all the inequalities of surface, has been made so well known that additional description is unnecessary here. Under these conditions the glacier does not act upon the lowest surfaces of rock beneath it, and these show by their roughness and irregularity that they were not shaped by its action. It, therefore, becomes evident that in such places some power must have acted or is now at work lower than the surfaces upon which the glacier moves.

Under the edge of the Great Aletsch Glacier I observed in a few places, that pieces were being broken from the lee edges of the *roches moutonnées* by the pressure concentrated upon certain stones or bowlders which had reached these edges in their progress under the ice, but I was not successful in my search for like phenomena in connection with other glaciers. But this action, even if we could suppose it to be sufficiently common, would serve to break away only the same prominent portions of the rock which the glacier abrades.

The ice of the glacier, however, is sufficiently plastic to conform to certain kinds of irregularities of surface, and of one of these there are good examples at the above-mentioned locality. There are long, narrow ridges, the trends of which are the same as the strike of the rock and nearly parallel with the direction of the motion of the glacier. A longitudinal section of one of these ridges gave an outline like that of an elongated *roche moutonné*, while a transverse section showed quite a regularly

* From the Proceedings of the Boston Society of Natural History, vol. xix, pp. 330–336, March 20, 1878.

† Proceedings of the Boston Society of Natural History, vol. xv, pp. 378–381.

corrugated surface. These corrugations originated in the bedded structure of the rock, the upturned edges having been rounded and smoothed by the action of the glacier. The ice had time enough to conform to these longitudinal furrows and ridges as it flowed over them lengthwise; and in August, 1876, as it passed the lee end of a ridge, it preserved the mould of the profile so perfectly that for more than twenty feet the blue arch presented a series of parallel furrows, like the flutings of a Doric column.* I also observed many other examples of the same kind, though none so regularly and beautifully perfect.

There was there at that time another highly interesting and instructive exhibition of glacial action. Within a few feet of the down-stream end of one of these elongated *roches moutonnées* and upon its crest, there was a bowlder fully three feet in diameter, which evidently had been slowly moving along this ridge for some distance, probably from its upper end. There were two sides of this block of stone which were not incased in ice, viz., the lower one resting upon the rock, and the one facing down the glacier. From the lower end of the ridge of rock I looked at the bowlder through a tunnel of pure, blue ice, which was continued as a deep furrow in the under surface of the glacier for fully thirty feet from its beginning. As this was produced by the ice moving over and beyond the bowlder, it was evident that the ice was moving more rapidly than the stone. I afterwards found other examples of the same kind, but none so favorably situated for a striking exhibition of this property of ice. It will be understood that these stones were sufficiently below the upper surface of the glacier to be removed from the effects of the ordinary changes in the temperature of the atmosphere. Although stones which are exposed to such changes may be frozen into the ice at the edges of the glaciers, yet I believe these were so situated as to correctly represent the conditions and movements of those at still greater depths. If this is correct, and I believe it is, it follows that such fragments of rock are not rigidly held in fixed positions in the under surfaces of glaciers and carried irresistibly along at the same rate, but that the constantly melting ice actually flows over them, and that their motion is one of extreme slowness, even when compared with the motion of the glacier itself.†

* I see by quotations from the "Nouvelles Excursions et Séjours dans les Glaciers et les hautes règions des Alpes," by Professor E. Desor, that he there described similar features which he observed in connection with the Aar Glacier in 1844, but I have not been able to obtain a copy of the work for examination.

† In an article in the Geological Magazine, Decade II, vol. iii, 1876, published during the same season that I was making these observations, and which I had not then seen, being away from home, Rev. T. G. Bonney clearly states the same conclusion, presenting as evidences the appearances of certain bowlders observed by him in 1875, near the terminations of the Glacier des Bois and the Glacier

If this is granted, it must then be admitted that the abrading power of glaciers is much less than if the fragments of rock were usually firmly set in the ice. This is one of the many reasons which I have for believing that the erosive power of glaciers is not sufficient, in itself alone, to account for the excavation of those valleys in which they are found.

Among the phenomena which attract the attention and obstruct the progress of the explorer under a glacier, is the abundance of streams. A short distance below the edge of the glacier the ice is constantly melting, and in every place accessible to the observer the water falls, usually in large drops but sometimes in streamlets. Thus the surfaces not covered by the ice are exposed to a constant fall of water, which, first forming numerous rivulets, soon collects in small and rapid streams. The dropping of the water and the rushing of the torrents, the frequent slipping of smaller fragments of stone which have been started by the rivulets and the occasional tumbling or plunging of a larger mass, the incidental cracking of the glacier and the frequent crash of pieces of falling ice, all unite in impressing upon the listener that this is a busy place. Where the glaciers rest upon the upper portions of the *roches moutonnées*, the streams are formed in the hollows between them which the ice does not fill; therefore, under such conditions their erosive power is exercised upon those lower portions of the rock-surface which are not effected by the movements of the glacier.

In estimating the erosive power of a stream we must take into consideration, not only its volume and velocity, but also the more important factor of the materials with which it is charged. The importance of this is well illustrated by the modern appliance called the sand-blast, in which it is not the violence of the current of air or steam but the sand which it carries with it, which cuts away the surfaces of stones, metals and glass with such astonishing rapidity. Sometimes this element has been overlooked, as, for example, when it has been argued that because pure water may rush violently over a rock for a long period without producing any perceptible change, therefore, the valleys which now are or formerly were occupied by glaciers must have been excavated by the ice rather than by the streams below it. A sub-glacial stream, considered as an agent of erosion, should never be compared with a stream of pure water. All of the streams beneath a glacier are charged with small, angular fragments of stone, such as glaciers transport in immense quantities. Any one who has walked over the middle and lower portions of a glacier in summer has not

d'Argentière. I do not learn from what he has written, however, that he saw the ice flowing over stones in the manner I have here described. It is, therefore, my pleasure to have witnessed what I consider to be a proof of the accuracy of the conclusion which Professor Bonney ably drew from other sources.

failed to notice the small fragments of stone which often darken and sometimes cover the surface. When these are examined they are found to be sharply angular; and if the examination is extended to the medial and lateral moraines, they will be found to contain immense quantities of similar materials. These small fragments, as well as large ones, find their way into the sub-glacial streams, in which by the sharpness of their angles they become most effective instruments in the work of erosion. The materials transported by ordinary streams, even when swollen by heavy rains, are of a different nature. The small stones and gravels which they receive are usually more or less rounded, while the finer materials are chiefly loam, clay, soil, or well-worn sand. The erosive power of a current carrying such old, worn, and often soft materials, is much less than that of one charged with the new and sharp instruments of the sub-glacial streams; hence the denuding agency of the latter should not be estimated by observations upon the former.

The excavating power of these streams is shown in the number of pot holes which they produce. The steepness and irregularity of their courses, the abundance of water with stones and sand, and in many places the presence of ice causing gyratory movements of the water, make these streams peculiarly efficient in this work. Sometimes these pot-holes succeed each other so closely in the course of the stream, that as they increase in size they unite and form a deep, narrow gorge, whose walls present a succession of their concave surfaces.

Furthermore, the ice of the glaciers often exercises a controlling influence upon the positions and courses of these streams. It is not uncommon to find a stream flowing along the edge of the glacier considerably below its surface, in a channel one side of which is ice and the other side rock. In such instances the streams are often supported by the ice at a considerable elevation above the bottom of the valley where they would otherwise be. The power which a glacier may have for preventing water from flowing directly into the lower portion of its valley, is well illustrated by the Märjelen See, a lake which owes its existence to the ice-wall of the side of the Great Aletsch Glacier which forms one end of the basin which it occupies.

The lateral streams above described are abundantly supplied with small and large pieces of stone from the lateral moraines, and they thus become agents in the erosion of the sides of the valleys. It will probably be remarked that such streams must naturally erode the ice more rapidly than the rock, but it must be remembered that the ice is constantly renewed by the motion of the glacier. It will be readily seen that such streams, by the peculiarities of their situation and action must exercise an influence in determining the precipitous character which the sides

of glacial valleys so often have. If it is objected that such water-worn surfaces are rarely met with upon the sides of valleys from which the glaciers have retreated, it must be remembered that the ice above the streams and the atmospheric agencies modify these surfaces after they have been left by the streams, hence the rocks have the features which they received from the last agent which acted upon them.

Still lower and quite underneath the side of the glacier there are larger and often much longer lateral streams, which are much more important agents in the excavation and formation of the valleys. These, flowing in channels of their own formation in the rock and quite below the ice, tend to deepen the valley along its edges and to give it that cañon-like form so often seen.

Sometimes the aqueous erosion under the sides of a glacier is greater than it is under the medial portion, and when this has been continued for long periods the edges of the valley have become the deepest portions, and when the lower end of the glacier has receded to this part of the valley it is often bifurcated, its terminations being upon opposite sides of the rocky eminence left in the central part of the valley. Such knolls or hills occur in the valleys of ancient glaciers, as, for example, in the valley of the Rhone at Sion, and they have always been a puzzle to the advocates of a purely glacial origin of such valleys. If, however, we duly recognize the power of sub-glacial streams, the hills which are sometimes left in positions where they have been fully exposed to the action of glaciers appear as a normal and not as an anomalous result of the agencies which have excavated such valleys.

With many other glaciers and often with other parts of the same glacier, the medial stream is the most important one in volume and power, and then it tends to make that part of the valley the deepest, and the glacier assumes a corresponding form.

In conclusion I will state that the observations of three summers among the glaciers of the Alps have led me to estimate the relative agency of glaciers and sub-glacial streams in the erosion of valleys as follows: viz., that the sub-glacial streams are of primary importance in working in advance of the ice in deepening and enlarging these valleys, and that the glaciers abrade, modify, and in a measure reduce the prominent portions left by the streams, and give them the well-known glaciated surfaces.

[I have not space in the narrow limits of this article to consider the valuable and exceedingly numerous contributions of others to the subject of glacial action.]

ART. XLVI.—*Notice of recent additions to the Marine Fauna of the eastern coast of North America, No.* 2; by A. E. VERRILL. *Brief contributions to Zoology from the Museum of Yale College.* No. XXXIX.

DURING the past summer Professor Baird established the headquarters of the U. S. Fish Commission at Gloucester, Mass. Numerous dredgings were made under the direction of the writer, in the U. S. Steamer Speedwell, commander Beardslee. Mr. Richard Rathbun, Mr. Sanderson Smith and others assisted in the invertebrate department, while Mr. G. Brown Goode, Mr. T. H. Bean and Mr. R. E. Earll, took charge of the Ichthyology. The temperatures were taken by Mr. Asaph Hall, Jr. Our dredgings extended over Massachusetts Bay and Stellwagen's Bank, and to the deeper waters of the Gulf of Maine, about forty-five miles east of Cape Ann. Although a very large and valuable collection, containing many additions to the fauna, was obtained by means of our dredges and trawls, more novelties, both among the fishes and invertebrates, were secured by inducing the fishermen engaged, in the fisheries of halibut and cod on the outer banks, to preserve and bring in the various things that become entangled in their trawl-lines. Many of the following species, some of them of great interest, were thus obtained by the fishermen, together with numerous specimens of many better known species, among which the most conspicuous and abundant are large and fine specimens of the corals, *Paragorgia arborea* and *Primnoa reseda*, while *Acanella Normani* has recently been brought in from many localities in considerable numbers.

ECHINODERMATA.

Pteraster pulvillus Sars. Norges Ecinod., p. 62, Pl. 6, figs. 14–16, Pl. 7, 8.

A well-developed specimen of this species was dredged in thirty-five fathoms, off the Isles of Shoals, N. H., by Dr. A. S. Packard, on the "Bache," in 1874. It may be distinguished from *P. militaris* by its more warty surface, more swollen form, with the rays narrower below and the transverse spines fewer, less prominent and less acute.

Porania grandis, sp. nov.

The greater radius of the larger one is 4·75 inches; radius of disk, 2·75. The greater radius of another is 4·35 inches; of disk, 2·70. The upper side, when fresh, was bright cherry-red; lower surface pale yellow. Easily distinguished by the nearly smooth, fleshy surface, without spines; but with two regular broad bands of soft slender papillæ along each ray on the upper side, and with radiating grooves on the lower side, which extend

also to the upper surface. Margin of disk without distinct spines, but with irregular rudimentary tubercles, covered by the skin. Adambulacral spines forming an inner row, two, united by a basal web, on each plate, and an outer series arranged in oblique transverse groups of about three; these are shorter and covered by the skin, which is everywhere finely granulose. No interbrachial spines, except one or two rudimentary ones, close to the mouth.

Two large and fine specimens of this species were taken on trawl-lines on the eastern slope of George's Bank, in about 220 fathoms, and presented by Capt. Anderson and the crew of the schooner Alice G. Wonson, August, 1878.

Asterina pygmæa, sp. nov.

A small species, perhaps young, with a rather flattened pentagonal disk, with edges concave, and very short obtuse rays. Upper surface covered with small, sub-acute, stoutish spines on the disk, mostly placed singly and not crowded; on the rays mostly in transverse groups of two or three on each plate. A short row of few conspicuous solitary pores for the papulæ are on each side of the base of the rays; margin of disk thin, fringed by a row of small slender spines borne on the ventral row of plates, which project more than the smaller dorsal ones; the latter bear a group of very small inconspicuous spines, and belong to the upper surface. Beneath, the disk is covered with soft skin, showing conspicuous radiating furrows between the relatively large, oblong, marginal plates, each of which bears a row of four to six small, slender, marginal spines on its outer end, but is elsewhere smooth, or, when dry, minutely granulose. There are eight of these plates on each interradial margin. The triangular interradial area has a few plates, some of which have one small acute spine. The ambulacral grooves are bordered by two rows of small, acute, rather stout spines on each side, those of the outer row usually standing erect, those of the inner ones often interlacing across the groove. Usually one inner and one outer spine to each plate, but close to the mouth, two inner ones sometimes on one plate. Smaller radius, $3{\cdot}5^{mm}$; greater, 5^{mm}.

Cashe's Ledge, Gulf of Maine, fifty-two to ninety fathoms. Dredged by Dr. Packard and Mr. Cooke on the "Bache," in 1873.

Archaster Floræ, sp. nov.

Five rays; greater radii, 85 to 88^{mm}; smaller, 15 to 18^{mm}; breadth of arms at base, about 20^{mm}; in middle, about 12^{mm}; paxilligerous portion in middle, 7 to 9^{mm}, or about twice as wide as upper marginal plates. Disk moderately large, flat, with the central opening raised on a slight eminence. Arms elongated, flat above, regularly tapered to slender acute tips. Dorsal surface with the paxillæ evenly and regularly arranged, mostly with

about fourteen to eighteen small, short, round-tipped spinules at the summit; of these, ten to twelve are usually divergent and border the edge, and are a little longer and more slender than the four to six more rounded ones that form a central group. Marginal plates forty-five to forty-eight on each side; upper ones mostly higher than long, except toward the tips, even and regular, thickly covered with small spinules which are finer and more slender around the margins, where they are crowded and divergent, those over the central part being shorter, larger and more obtuse, with occasionally one or two, small, acute spines rising from the center of the plate, especially along the middle of the arm. Lower marginal plates opposite the upper and a little higher, covered with the same kinds of spinules, but mostly having a central, vertical row of two to four, slender, acute, spines, which are more or less appressed and scarcely longer than the plates, but longer than those on the upper plates. Adambulacral plates each with an inner fan-shaped group of eight or nine, slender, rather long spines, the central, longest, and with an outer, more or less circular, loose, divergent cluster of eight to ten shorter, slender spines; a similar, but mostly smaller and more regular, cluster occupies each of the pavement-like plates that cover the triangular interbrachial area and extend out along the arms between the marginal and adambulacral plates, in about three rows toward the base, but gradually narrowing to one, farther out.

Oral plates prominent, forming narrow elliptical "jaws" surrounded by two close rows of short spines, those of the inner row slightly divergent with enlarged rough tips, in close contact; those of the outer row shorter, with the tips flattened and closely pressed against the inner ones, so as to support them externally.

Color, in life, light purplish red above, yellow beneath. Dredged by us in 1877, about thirty miles south from Halifax, N. S., in 100 fathoms, fine compact sandy mud, associated with *Archaster arcticus*, *Astrogonium granulare*, *Asterias stellionura*, *Hippasteria phrygiana*, *Antedon Eschrichtzii*, *Pennatula aculeata*, *Eudendrium rameum*, etc.

Ophiacantha sp. Related to *O. cosmica* (fide Lyman).

Distinguished by having the disk thickly covered with minute, three-pronged, slender spinules. Mouth-plates extending into interbrachial spaces. Eastern slope of George's Bank, 220 fathoms, (schooner "Alice G. Wonson.")

Astrophyton eucnemis Müll. and Troschel.

Several specimens of this species, not before known south of the Gulf of St. Lawrence, were found clinging to specimens of *Paragorgia arborea*, from the eastern slope of George's Bank, in about 220 fathoms, (schooner "Alice G. Wonson.")

Astrochele, gen. nov.

Disk covered with small scales, above and below. Radial ribs well-developed. Genital openings small, oblique, close to base of arms, at each end of a depression in edge of disk. Teeth and tooth-papillæ spiniform, mouth papillæ irregular, small or rudimentary, few or solitary. Arm-spines thorny and claw-like. Arms annulated, granulated, long, slender undivided.

Astrochele Lymani, sp. nov.

Disk strongly five-lobed, the interbrachial spaces, in the dried specimen, much incurved. Radial ribs extending to near the center, highest and rather angular at the outer end. Whole surface of disk, including ribs, closely covered with small, convex, rounded, warty scales, with a somewhat larger central scale, surrounded by a circle of similar ones near the inner ends of the ribs and a few others irregularly placed between the ribs. On the ribs some of the scales are conical. Under surface, except jaws, covered with small round scales or granules concealing the plates. Teeth slender, acute, rough, in a single row, except the under ones (or tooth-papillæ), which are in pairs, but of same shape. On the side of jaws, near the tip, there is a very small acute conical mouth papilla, and sometimes another, still smaller, near the middle; a similar one is seen lower down on the lateral face of some of the jaws. Arms granulated like the disk, the annular ridges bearing also a row of small, strongly curved, acute, claw-like hooks, which become larger and more prominent toward the tips of the arms, especially beneath. Toward the base of the arms there are on the prominent, side arm-plates, beneath, about three spines having thickened bases and narrowed, acute, thorny, claw-like, brown tips.

Diameter of disk, 7^{mm}; length of arms four or five times as much. Found clinging to *Acanella Normani*, from south-eastern slope of Le Have Bank, 200 fathoms, Capt. Wm. McDonald, (schooner N. H. Phillips).

HYDROZOA.

Blastothela, gen. nov.

Hydroid allied to *Myriothela* and *Acaulis*. Body elongated, sessile, attached at base by slender, simple, root-like processes; a circle of slender tentacles near the base; above these are many stout simple processes (blastostyles), which bear the small sexual zooids (gonophores) on their sides; upper portion of body elongated, covered with small capitate tentacles.

Acaulis differs in having no blastostyles, and in the mode of attachment; *Myriothela* in having branched blastostyles, but no basal tentacles.

Blastothela rosea, sp. nov.

Body elongated and rather slender in expansion, with the upper portion round and usually nearly cylindrical, obtuse,

covered everywhere with small crowded capitate tentacles, with short pedicels; tip obtuse; blastostyles numerous, clustered about the base, large, elongated, cylindrical, obtuse or tapered at the tip, the sides covered with many very small, short, obtuse or capitate papillæ (? undeveloped gonophores), and bearing, among them, the few rounded, more or less irregular gonophores. Basal tentacles slender, slightly capitate, not so long as the blastostyles, and not in a regular circle.

Color light rosy red; the tentacles and gonophores whitish. Length, 24^{mm}; diameter, 10^{mm}; length of tentaculiferous portion, 13^{mm}; its diameter, 3·5^{mm}.

Gloucester, Mass., outer harbor, attached to *Ptilota serrata*, in seven fathoms, sandy bottom. A specimen, apparently the young of this species, was taken by us at Eastport, Me., in 1872, in about twenty fathoms.

Dicoryne flexuosa G. O. Sars.

Numerous specimens of this interesting hydroid were dredged both this year and last, in many localities, in the Gulf of Maine and off Nova Scotia, in 50 to 125 fathoms. It grows usually upon the shells of living *Neptunea Stimpsoni* and *N. decemcostata*, sometimes also on shells inhabited by *Eupaguri*. Often associated with *Eudendrium rameum*.

ANTHOZOA.

Pennatula borealis Sars.

Pennatula grandis Ehrenberg (non Pallas).

A fine large specimen of this species, taken on a trawl-line, between Sable I. Bank and Banquereau, N. S., in about 250 fathoms, was presented by Capt. J. W. Collins, of the schooner "Marion." It was previously known only from northern Scandinavia. Its height, preserved in alcohol, is 20·5 inches; length of peduncle to first alæ, 5·75; diameter of peduncle, in middle, ·5; of swollen portion, 1·10; of rachis, ·70; breadth across largest alæ, 5; length of largest alæ, 2·25; breadth, ·75; length along dorsal edge, 1·90; distance between alæ, ·30 to ·50.

Alæ 36 on one side, long, subtriangular, with the polyps in groups on the dorsal edge, forming two to four rows; polyp-cells large and prominent, with eight sharp, spiculose, projecting points. Middle of ventral surface naked, smooth, bordered on each side with a band of rudimentary zoöids. Color, bright dark red, polyps paler.

Balticina Finmarchica Gray.

Virgularia Finmarchica Sars, 1850.
Pavonaria Finmarchica Kölliker, Pennatuliden, p. 243.

A specimen of this rare species, not before known from America, was taken with the preceding and presented by Capt. Collins. The upper portion had been broken off, leaving the axis exposed for two inches, and to this two specimens of

Urticina nodosa were attached, their basal margins having, in each case, united around the axis, which is small and round.

The uninjured portion is 12·5 inches long; breadth across largest alæ. ·60; peduncle, to alæ, 4·50; to first zoöids, 3·20; breadth of largest alæ, ·50; height, without polyps, ·33; length of their acute marginal lobes, ·10; diameter of peduncle, ·30; of rachis, ·20.

Anthomastus, gen. nov.

Alcyonarian forming a large rounded polypiferous mass, raised on a short, stout, barren peduncle. Polyps few, very large, spiculose, entirely retractile into 8-rayed cells. Rudimentary zoöids numerous, minute, scattered between the polyps. Cœnenchyma abundant, firm, finely spiculose.

Anthomastus grandiflorus, sp. nov.

Corallum broadly capitate, surface finely granulose; polyp-cells not prominent. Peduncle, 50^{mm} broad, 30 high; polypiferous summit, 82 broad, 30 thick; expanded polyps, 36 long; 8 in diameter; 25–28^{mm} (1–1$\frac{1}{8}$ inch) across tentacles. Spicula of surface minute, rough stellate and capitate; beneath the surface are long slender spicula, and slender fusiform ones are abundant in the tentacles and pinnæ. Color, deep cherry-red. Off Sable Island, N. S., in about 250 fathoms, schooner Marion (coll. Newcomb). Two specimens were obtained.

Acanthogorgia armata, sp. nov.

Corallum slender, flexible, much and irregularly branched, somewhat in a plane, the branches occasionally uniting. Cœnenchyma thin, filled with conspicuous, white, rough, curved, fusiform spicula. Polyp-cells very much elongated, the length six to eight times the diameter, often curved, clavate, or capitate, smallest at base and suddenly enlarged near the summit, which is surmounted by eight groups of long, divergent, sharp spicula; sides of polyp-cells with eight low ridges, covered with elongated spicula, having an irregular chevroned arrangement. Height, about 8 inches; breadth, 6; length of cells, 5^{mm} to 8^{mm}; their diameter at base, ·8 to 1^{mm}; at summit, 1 to 1·5^{mm}. Color, ash-gray; axis, yellowish-brown.

Off Nova Scotia, 300 fathoms, Capt. T. Goodwin (sch. Elisha Crowell). A second specimen from off George's Bank, in about 220 fathoms, Capt. Anderson (schooner Alice G. Wonson).

Keratoisis ornata Verrill.

Of this species, described in the last number of this Journal, another specimen, taken with the two preceding, has been received from Mr. Geo. K. Allen, of the schooner "Marion." This has the cœnenchyma and polyps upon it, and is considerably taller, but the joints lack the golden color, and are plain brown. The polyp-cells are pale salmon, prominent, elongated,

expanding toward the end, and are crowded equally over the whole surface; they are covered with large, conspicuous, acute spicula, which are grouped at summit into eight sharp projecting points. The cœnenchyma is thin, translucent, yellowish, filled with long, slender, fusiform, acute spicula.

Height (base absent), 40 inches; diameter of trunk, without cells, ·28; length of cells, ·20; diameter, ·08; calcareous joints of stem, 2 to 2·5; flexible ones, ·15 to ·18. One branch is 27 inches long, without dividing. With this, five additional specimens of *Acanella Normani* were taken.

Flabellum Goodei, sp. nov.

A fine large species with a long, deep, compressed calicle, its longer diameter being nearly three times as great as the shorter. In a side view the summit is broadly rounded and the lateral edges form an angle of about 144°; they are formed by prominent acute costæ, while the principal lateral costæ are large, elevated, obtuse and irregularly roughened by numerous, obliquely ascending, raised lines, arranged in chevrons. There are eleven principal costæ on each side, making twenty-four in all, each of which corresponds to one large and two small septa; a small ridge, corresponding to the latter, is often seen on either side of the large costal ridges; alternating with the latter there are similar, but much smaller, secondary costæ. All the costæ become fainter toward the base, which terminates in a tapering subacute pedicle. Wall very thin, with a glossy epithecal coating; the edge recedes greatly between the principal septo-costal summits, which are very prominent. Septa about 96, very irregular, thin, with wide interspaces, the average distance between the twenty-four principal septa being about 10^{mm}; between the smaller ones, about 3^{mm}; inner side of the septa nearly straight, thin, smooth, the upper end mostly broadly rounded, often subtruncate at tip, scarcely projecting above the costal wall, and not recurved. Septa of the third and fourth cycles successively much narrower, those of the third with the summits much less elevated, while those of the last cycle rise nearly as high as the primaries, but are very much narrowed. Lateral surfaces of septa are smooth, but show lines of growth.

Height, 53^{mm}; along lateral edges, 42; length of calicle, 70; breadth, 26; space between inner edges of large septa, 5 to 8^{mm}. Color, light yellowish brown when fresh.

One living specimen from the eastern slope of George's Bank, in about 220 fathoms (schooner Alice G. Wonson).

Lophohelia prolifera Edw. and Haime.

A fragment of a large, dead, but nearly fresh, specimen of this coral, taken about thirty-nine miles S.S.W. from the N.W.

Light of Sable Island, in 160 fathoms, was presented by Dennis Thelneny (schooner Wm. Thompson.)

MOLLUSCA.

Sepiola leucoptera, sp. nov.

Species probably small, but the three specimens observed are probably not full grown. Body short, depressed, with the mantle smooth. Ventral surface, in middle, with a somewhat flattened heart-shaped or shield-shaped area, surrounded, except in front, by a silvery white band, having a pearly or opalescent luster. Eyes small, with round pupils. Fins large, in the living specimens nearly as long as body, broadly rounded; the posterior lobe reaches nearly to end of body, the anterior edge beyond front of mantle, to the eye. The anterior edge of the mantle is emarginate beneath; above it is broadly attached to the head. Sessile arms short; upper ones shortest; third pair largest; tentacular arms slender, extending back to end of body. Upper surface of body opalescent in some lights, thickly spotted with orange-brown, spots most numerous in middle line and extending to upper surface of head, and some also on outer surfaces of arms; anterior part of head white; fins, arms and extremity of body, translucent bluish white; upper surface of eyes opalescent, with silvery blue and red tints; head, below the eyes, silvery white; above eyes, blue. Length to base of arms, 14^{mm}, in alcohol; of mantle above, 8^{mm}; breadth, 7^{mm}; breadth across fins, 16^{mm}.

Gulf of Maine, 30 miles E. from Cape Ann, 110 fathoms, muddy bottom, associated with *Rossia sublævis* and *Octopus Bairdii*, Aug., 1878.

Chiton (*Acanthopleura*) *Hanleyi* (Bean).

A well-characterized living example of this species, new to America, was recently detected by Mr. Sanderson Smith, of our party, while dredging 8½ miles S. by E. ½ E. from Cape Ann, in thirty-eight fathoms, sand and gravel.

Pecten vitreus (Chemnitz).

This elegant little species, not before known from America, has been found in considerable numbers attached to *Paragorgia arborea* and *Acanella Normani*, from 220 fathoms, on the eastern slope of George's Bank (from the "Alice G. Wonson"), and on *Acanella*, from Banquereau, 150 fathoms, from Capt. Morrisey (schooner "Alice M. Williams").

Easily distinguished by its delicate, white, translucent shell; covered on both valves with very fine radiating striæ, and with delicate concentric lamellæ, which rise into numerous, minute, delicate, vaulted scales. The largest specimens are about ·5 of an inch in diameter.

ART. XLVII.—*Discovery of two more new Planets;* by C. H. F. PETERS. (From a letter to the Editors, dated Litchfield Observatory of Hamilton College, Clinton, N. Y., October 5, 1878.

Two more planetoids have been discovered here, one on September 22d, and the other on September 30th. In order to avoid confusion, as the numbers perhaps may yet suffer some change, I have given immediately names to them, calling the former *Ismene*, the latter *Kolga*. The planet discovered on September 9, I have named *Phthia*.

The following observations have been obtained:

[191] *Ismene;* 11·5 magnitude:

1878. Ham.	Coll. m. t.	App. α.	App. δ.	
h. m. s.		h. m. s.		
Sept. 22, 16 — —		1 10 8	+4° 56′ —″	(approx.)
27, 16 19 21		1 7 16·96	+4 32 7·2	12 ring micr. comp.
30, 13 21 51		1 5 37·53	+4 17 57·4	10 fil. micr. "
Oct. 2, 13 15 18		1 4 27·04	+4 8 18·5	10 " " "

[192] *Kolga;* 10·5 magnitude:

h. m. s.		h. m. s.		
Sept. 30, 14 2 46		23 45 4·56	−8° 8′ 35·3″	10 fil. micr. comp.
Oct. 1, 10 20 20		23 44 33·66	−8 15 15·8	12 ring " "
2, 12 28 49		23 43 50·44	−8 23 36·8	10 filar " "
4, 13 10 48		23 42 35·61	−8 38 57·4	12 ring " "

The strong motion of the last planet in declination discards the idea of its being identical with [162] *Laurentia*, which was observed only in one appearance, and has not been found, neither in the preceding nor in the present opposition. The numbers attributed to the last two planets therefore are upon the assumption, that the planet found by Professor Watson on Sept. 22d also is not identical with [162].

ART. XLVIII.—*The Sonorous Voltameter;** by THOMAS A. EDISON, Ph.D.

THE sonorous or bubble voltameter consists of an electrolytic cell with two electrodes, one in free contact with a standard decomposable solution and the other completely insulated by vulcanized rubber except two small apertures, one of which gives the solution free access to the insulated electrode, and the other allows the escape of bubbles of hydrogen as they are evolved by electrolysis. With a given current and a given resistance a bubble is obtained each second, which is seen at the moment of rising and which at the same time gives a sound when it reaches the air. The resistance may be reduced so as to give

* Read at the St. Louis meeting of the American Association.

one bubble in one, five, ten or fifty seconds, or in as many hours. I have compared this instrument with the ordinary voltameter and find it much more accurate. By the use of a very small insulated electrode and but one aperture, through which both the gas and water current must pass, great increase of resistance takes place at the moment when the bubble is forming; and just before it rises, a sounder magnet included within the battery circuit opens, closing again when the bubble escapes, thus allowing by means of a Morse register the time of each bubble to be recorded automatically. This apparatus, when properly made, will be found very reliable and useful in some kinds of work, such as measuring the electro-motive force of batteries, etc. By shunting the voltameter, and using a recorder, it becomes a measurer not only of the current passing at the time, but also of that which has passed through a circuit from any source during a given interval.

Menlo Park, N. J., July 13, 1878.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Behavior of Hydrogen peroxide with the Alkalies.*— In his second paper on hydrogen peroxide, Schöne discusses the relations of this substance to the alkalies, with particular reference to the decomposing action of these upon the peroxide; an action classed as "catalytic" by Berzelius. His first efforts were directed to the production of peroxide hydrates of the alkalies analogous to those of the alkaline earths. For this purpose a solution of hydorgen peroxide containing three or four per cent, was mixed with a ten per cent sodium hydrate solution in equivalent proportions. A rise of 4° to 5° C. took place, with a very slight evolution of gas. On concentrating the solution in a vacuum, efflorescent crystals separated on the edges at first, and then large tabular crystals formed in the solution. If instead of evaporating the solution, once and a half or twice its volume of absolute alcohol be added, and it be allowed to stand in a cool place for twenty-four hours, spear-shaped crystals often several centimeters long, appear in the solution. On analysis they give numbers agreeing with the formula $Na_2O_2 \cdot (H_2O)_8$. They are identical with those obtained later by Fairley* in the same manner, and with those obtained by Vernon Harcourt† by solution of sodium dioxide in water. When rapidly heated in a glass tube the crystals melt, froth, evolve oxygen and leave sodium hydrate. In closed vessels, the same decomposition takes place more slowly, requiring three months for completion. Absolute alcohol preserves it pretty well, if carbon dioxide be excluded. On examining the efflorescence above

* J. Chem. Soc., xxxi, 1, 125, 1877. † Id., xiv, 274, 1862.

mentioned, it was found to be a mixture of the substance already described and of another substance having the formula $Na_2H_4O_6$, or $Na_2O_2(H_2O_2)_2$, a compound of sodium peroxide with hydrogen peroxide. To prepare it, a mixture of one molecule of sodium hydrate and about three and a half molecules of hydrogen peroxide solution are mixed and evaporated in vacuo. The crystals are colorless and very minute; are at first transparent, very soluble in water, dissolve in this and in dilute acids without evolution of gas, and effloresce in dry air. In vacuo over sulphuric acid they lose four molecules of water, leaving $Na_2H_4O_6$. A similar peroxide hydrate was obtained with potassium, though mixing the solutions and evaporating gave only a yellow amorphous mixture of potassium tetroxide and potassium hydrate, $K_2O_4+(KOH+H_2O)_4$. But if excess of hydrogen peroxide be used, and the evaporation be conducted at a low temperature $-10°$ C., a white opaque mass results which is very hygroscopic and has the formula $K_2H_4O_6$, or $K_2O_2(H_2O_2)_2$. These facts the author uses to explain the "catalytic" action, as follows: The decomposition of hydrogen peroxide in alkaline solutions is due: 1st, to the tendency of the alkalies to form compounds of the composition $R_2H_4O_6$ or $R_2O_2.(H_2O_2)_2$; 2d, to the tendency of the alkali metal within this compound to oxidize itself to a higher oxide, the tetroxide; and 3d, to the reduction of the tetroxide to dioxide by the water present.—*Liebig's Annalen*, cxciii, 241, August, 1878.

G. F. B.

2. *On a Series of Magnetic Compounds having the Formula* $R''Fe_2O_4$.—Of the possible compounds of ferric oxide with the basic oxides isomorphous with ferrous oxide, only two, $MgFe_2O_4$, prepared by Deville, and $ZnFe_2O_4$, by Ebelman, both produced at high temperatures, are known. List has undertaken to prepare these compounds in the wet way. A ferric chloride solution as nearly neutral as possible, was precipitated with excess of lime water or of calcium saccharate, the bright leather-brown precipitate washed with lime water, filtered, dried and ignited. A dark brown friable powder, having the composition $CaFe_2O_4$, was obtained, which was strongly attracted by the magnet. Barium-ferric oxide, obtained similarly, had similar properties. The magnesium compound, prepared either by adding magnesia to a neutral solution of ferric chloride or by adding potassium or sodium hydrate to mixed solutions of ferric chloride and magnesium sulphate, is a cinnamon-brown powder, strongly magnetic. Manganous, zinc, nickelous, cuprous and lead oxides yielded like magnetic compounds. Even potassium and sodium oxides, ignited with ferric oxide, yield a compound attracted by the magnet.—*Ber. Berl. Chem. Ges.*, xi, 1512, Sept., 1878. G. F. B.

3. *On the Copper-zinc couple and on Nascent Hydrogen.*—In view of the fact that finely divided copper charged with hydrogen converts niter into nitrite and ammonia and reduces potassium chlorate to chloride, Gladstone and Tribe have been led to study the reducing action of palladium and platinum-hydrogen and to

compare it with that of the copper-zinc couple. They also treat copper-hydrogen and carbon-hydrogen. They find a close analogy between some actions of the copper-zinc couple, of occluded hydrogen and of the so-called nascent hydrogen, and conclude that the great power of hydrogenization and reduction of the copper-zinc couple depends on the absorption of hydrogen by the finely divided metal. The activity of the hydrogen in these cases may be explained by supposing (1) that its energy is increased by a more negative element, or (2) that the atomic condition of occluded hydrogen differs from that of ordinary hydrogen, or (3) that the increased power of the hydrogen is due to its condensed condition. Since in those changes effected by nascent hydrogen, the gas is set free in contact with a metal which condenses it, the authors incline to the opinion that the activity of nascent hydrogen is due only to its occluded condition.—*J. Chem. Soc.*, xxxiii, 306, Aug., 1878. G. F. B.

4. *On the Action of Nitrous acid on Unsaturated Hydrocarbons.*—Tönnies has observed that when a concentrated solution of potassium nitrite is mixed with a solution of an unsaturated hydrocarbon in glacial acetic acid, products are obtained which analysis shows to be direct addition products of the hydrocarbon and N_2O_3. Thus furfurbutylene gives a beautifully crystallized compound $C_8H_{10}O.N_2O_3$, phenylbutylene gives $C_{10}H_{12}.N_2O_3$, and styrol, totylbutylene, anethol and amylene give similar bodies. On reduction, these bodies give bases which contain in the place of the N_2O_3 group, an amido and an hydroxyl group. Thus the furfurbutylene compound affords a well crystallized hydrochlorate $C_8H_{10}O.OH.NH_2.HCl$, and the phenylbutylene compound gives $C_{10}H_{12}.OH.NH_2.HCl$. Hence the nitrous oxide, N_2O_3, splits into NO and ONO, so that the compound may be considered a nitroso-substitution product, on the one side, and a nitrous ether on the other. With this view the results of reduction agree, the nitroso-substitution product being always converted into an amido-compound, and the nitrous ether into an alcohol.—*Ber. Berl. Chem. Ges.*, xi, 1511, September, 1878. G. F. B.

5. *On the Production of Methyl Aldehyde.*—The method originally described by Hofmann for preparing methyl aldehyde consisted in passing the vapor of methyl alcohol mixed with air over an ignited platinum spiral. Later Volhard, producing the aldehyde by condensing the vapors from an aphlogistic lamp fed with methyl alcohol, showed that the condensed liquid contained only one per cent. Hofmann has now devised an improved method of preparation which consists in passing a suitable mixture of methyl alcohol vapor and air through a platinum tube containing a bundle of platinum wires, moderately heated. Abundance of methyl aldehyde is formed and on condensing the vapors a liquid is obtained which contains not less than five per cent of this substance. Since the process is continuous, large quantities may thus be prepared. By removing the alcohol by distillation and the water by freezing the liquid may be concentrated so as to contain ten per

cent of methyl aldehyde.—*Ber. Berl. Chem. Ges.*, xi, 1685, September, 1878. G. F. B.

6. *On the Determination of Phenol volumetrically.*—DEGENER has proposed a method for the volumetric estimation of phenol based upon the fact that bromine in aqueous solution acts upon phenol dissolved in water producing tribromphenol and hydrogen bromide: $C_6H_5OH + (Br_2)_3 = C_6H_2Br_3OH + (HBr)_3$. On adding the bromine water, the solution at first is clear; but soon it becomes turbid and finally on continued agitation, a snow-white voluminous curdy precipitate, consisting of fine interlacing needles, is thrown down, leaving the liquid clear. The slightest excess of bromine is recognized by potassium iodide and starch paper. To estimate an amount of phenol, up to five per cent, it is sufficient to add one drop of a bromine solution in excess containing forty grams bromine and half as much potassium bromide in a liter, provided the titered fluid does not exceed forty to fifty cubic centimeters. The titer of this bromine water, which varies from day to day, is fixed by adding a known quantity to a solution of potassium iodide, and titering the iodine set free with sodium hyposulphite. A series of experiments with phenol showed the process to be accurate to 0·12 per cent.—*J. prakt. Ch.*, II, xvii, 390, July, 1878. G. F. B.

7. *Vanillin in Gum Benzoin from Siam.*—JANNASCH and RUMP have succeeded in preparing vanillin from the gum benzoin of Siam, in which gum it was first discovered by the latter chemist. The finely divided gum is intimately mixed with half its weight of calcium hydrate in an iron vessel, water being added to make a stiff paste. Ten or twelve times the quantity of boiling water is added with continued stirring, the solution is freed from benzoic acid by acidifying it, and the acid filtrate is extracted with ether. On evaporation of the ether, impure vanillin is left. After recrystallization from water, it is soluble in ether, alcohol, chloroform, glacial acetic acid, less so in cold benzene, crystallizing from all in prismatic crystals. It fuses at 81°, reddens litmus when in solution, expels carbon dioxide from carbonates forming salts, gives a dirty green or violet color with ferric chloride, has the taste and odor of vanilla and precipitates lead acetate and silver nitrate. Purified by hydrosodium sulphite its analysis gave numbers agreeing with those of vanillin. Petroleum ether, boiling point below 90°, dissolves it abundantly when hot, scarcely at all when cold. It crystallizes from this solvent on cooling in splendid groups of long highly refracting prisms of considerable size.—*Ber. Berl. Chem. Ges.*, xi, 1634, September, 1878. G. F. B.

8. *On the Alkaloids of the Aconites.*—WRIGHT and LUFF, in their third and concluding paper on the alkaloids of the aconites, discuss, (1) the action of saponifying agents on aconitine, (2) the action of acids on aconitine, (3) the action of organic anhydrides on aconitine, aconine and pseudaconine, (4) the decomposition products of picraconitine, and (5) the alkaloid constituents of aconite roots generally. As a result of their investigations they

conclude: 1st, that *Aconitum ferox* roots contain a characteristic crystallizable and highly active alkaloid, pseudaconitine $C_{36}H_{49}NO_{12}$, the aurochloride and nitrate crystallizing. 2d, *A. napellus* roots contain chiefly aconitine, $C_{33}H_{43}NO_{12}$, crystallizable, fusing at 184°, and forming crystallizable salts. 3d, Pseudaconitine and aconitine readily lose water, forming apo-derivatives closely resembling the original bases. 4th, Saponifying agents break up pseudaconitine, aconitine and picraconitine, forming benzoic acid or a derivative of it, and new bases, pseudaconine $C_{27}H_{41}NO_2$ aconine $C_{26}H_{39}NO_{11}$, and picraconine $C_{24}H_{41}NO_9$. 5th, On treatment with organic acids or anhydrides, aconitine and pseudaconitine lose the elements of water and form derivatives in which H is replaced by an acid radical. 6th, Aconine and pseudaconine form analogous derivatives by the action of organic anhydrides and perhaps also of organic acids. 7th, Certain acids, however, only transform aconine and pseudaconine into apo-derivatives. 8th, Since there is no particular difficulty in obtaining well crystallized salts and bases both from *A. ferox* and *A. napellus*, the use of the amorphous precipitated substances at present sold as aconitine should be discontinued and that of the crystallized alkaloids and their salts substituted.—*J. Chem. Soc.*, xxxiii, 318, Aug., 1878. G. F. B.

9. *On a supposed new element Mosandrum.*—Dr. J. Lawrence Smith, in a recent article in the Comptes Rendus (July 22, 1878) has announced the discovery of a new earth in the samarskite of North Carolina. This earth belongs to the cerium group and to it the name Mosandra, or Mosandrum oxide has been given. M. Marignac, to whom some of the material had been submitted, has suggested (C. R., Aug., 1878) that the supposed new earth is probably identical with *terbia*. Dr. Smith, while admitting the presence of the terbia in the mineral still claims that a distinct earth—the mosandra—is also present; he has the subject still under examination.

10. *Specific Heat of Glucinum.*—The specific heat of this elementary substance has been very carefully determined by Nilson and Petterson, and the results of their investigation are given in the Ann. de Chim. et Phys. for July. These chemists prepared glucinum by heating to a red heat in a massive iron cylinder—hermetically closed by a screw-cap—a mixture of chloride of glucinum and metallic sodium. The product was a mixture of common salt and glucinum, which when washed with water left the metal in brilliant spangles, dendrites or globules. The metal thus prepared is described as of the gray color of steel or tin, as very hard, and having a great tendency to crystallize. The globules readily break under the hammer, and the metal does not melt at a temperature at which common salt rapidly volatilizes. It undergoes no change in the air even when heated to a high temperature, and in a current of oxygen gas it remains unaltered at a red heat. The vapor of sulphur is without action upon it, but in the oxidizing flame of a blowpipe the metal becomes covered with a coating of oxide, but without any appearance of igni-

tion. Glucinum does not act on pure water, either at the ordinary temperature or when heated. It decomposes, however, the hydrates of potassium and sodium as well as hydrochloric and sulphuric acids, determining a brisk evolution of hydrogen when the materials are heated. Nitric acid attacks the metal more slowly. When heated in a current of dry chlorine, the metal burns with great brilliancy, yielding white crystals of its chloride besides a small red sublimate of ferric chloride and a residue of undecomposed glucina. This reaction indicates the nature of the impurities, and analysis showed that the crude metal contained

Silica	0·99
Iron	2·08
Glucina	9·99
Glucinum	86·94
	100·

An accurate knowledge of the nature and amount of the impurities enabled the experimenters to deduce from the observed specific gravity of the crude metal 1·9101 the specific gravity of pure glucinum, which they fix at 1·64. In like manner the specific heat of pure glucinum was deduced from that of the crude metal determined with Bunsen's ice calorimeter, after the method of Schüller and Wartha. The result calculated from the mean of four observations gives for the specific heat of glucinum 0·4084. This result is very interesting, as it indicates a closer relation between glucinum and aluminum than has usually been supposed to exist. The specific heat of aluminum multiplied by its atomic weight gives the product $0{\cdot}2143 \times 27{\cdot}5 = 5{\cdot}89$, and if we assume that glucina, like alumina, is a sesquioxide, then the atomic weight of glucinum would be 13·95 and $0{\cdot}4084 \times 13{\cdot}9 = 5{\cdot}70$; while, on the other hand, if glucina is a protoxide, the atomic weight of the element would be 9·3, which when multiplied by the specific heat just found, would give a product wholly irreconcilable with the usual theory. The same conclusion in regard to the constitution of glucina was reached by the writer several years since, on finding that in the mineral Danalite alumina might replace glucina. It is also worthy of notice that if this view of the constitution of the oxide is correct, the atomic weight of glucinum is one half that of aluminum, within the limit of uncertainty which still attaches to these values. J. P. C., JR.

11. *Photometric Measurements of Electric Lights.*—Mr. W. Abney uses for this purpose the two shadows of a metal rod which is 1 cm. in diameter, 7·5 cm. long. The shadows are 7·2 cm. distant from one another and are thrown upon a screen. By means of a heliometric adjustment and a divided lens the two images of the shadows (seen through oiled paper) are made to approach each other and are observed through an eye-piece. The lights are made equal by the approach or recession of one. With the use of homogeneous lights the measurements are very exact; for instance, in the comparison of a candle and a lamp the ratio varies from 1 : 10·18 to 1 : 10·26. By means of red glass and an

ammoniacal solution of copper the light of a self-regulating electric lamp, provided with carbons of one-half inch square section and run at different speeds by means of a gram machine, was compared, under varied circumstances of work and resistance of circuit, with a parafine lamp. Reflected light was carefully shut off and the light passed through a square opening of eighteen inches in a wall of the laboratory. The actinic effects were also compared according to the method of Roscoe. It was found that the brightness, or intensity, as well as the actinic effect, increased in a greater ratio than the number of revolutions of the generator and the horse power consumed. The increase was slower for the red rays, quicker for the blue and quickest for the actinic effect. The following table exhibits this result:

No. of revolutions.	Horse power.	Blue light.	Red light.	Actinic effect.
240	1·6	360 candles.	180 candles.	----
350	2·5	750 "	----	890 candles.
460	5·6	2500 "	860 "	2750 "
540	--	6500 "	1620 "	----
565	9·0	----	2100 "	11020 "
580	--	----	----	----

The resistance of the voltaic arc was about 0·18 of an ohm with 375 to 383 revolutions per minute; the electromotive power of the machine was 111 volts. The resistance of the circuit was about 0·5 of an ohm.—*Proc. Roy. Soc.*, xxvii, 157–166, 1878; *Beiblätter Physik und Chemie*, ii, 497. J. T.

12. *A new Electric Lamp.*—M. G. Reynier describes in the Comptes Rendus, 1878, lxxxvi, p. 1193–94, a light which obviates the use of regulators. It consists simply of a thin rod of carbon which is connected with one pole of the electric generator and is pressed against a wheel which is connected with the other pole. The carbon glows at the point of contact and as it burns away moves the wheel to another point of contact. The inventor claims to have produced a light by means of four Bunsen elements and to have produced several lights in the same circuit. J. T.

13. *The strength of the Electric Telephonic Currents.*—Bosscha has made a determination of the relative comparative strength of currents which are generated by the voice in telephones. Upon the middle of the plate of a horizontal telephone a stiff bristle was attached and the excursions of this were observed through a microscope which permitted of a movement of a thousandth of a millimeter (mikron μ). Movements of 5·77 to 7·77 mikron indicated in one telephone (numbered 3) currents of 0·1627 and 0·2337 Weber's unit, showing that the currents were nearly proportional to the movements. The unit of current gave a movement $\varepsilon = 34{\cdot}3\mu$. With three other telephones numbered 1, 2 and 4, ε had the values $\varepsilon = 22{\cdot}5\mu$, $\varepsilon = 8{\cdot}7\mu$ and $35{\cdot}9\mu$. In order to ascertain the limit of currents which produced audible tones in the telephone, the instrument was placed in a circuit with a Daniell cell and

the resistances were varied. In all four telephones, tones were heard when the strength of the current and the values of ε were as follows:

	1	2	3	4
S	0·000100	0·000153	0·000084	0·000066
ε	0·00225μ	0·00133	0·00288	0·00237

With a movement equivalent to $\frac{1}{200}$ of the wave-length of sodium the telephone was heard. This explains the fact that Professor Bell heard sounds when the space between the vibrating membrane and the magnet was filled with a cork. Bosscha thus shows that Professor Bell's hypothesis that the movement of the plate was molecular is unnecessary. The currents which were necessary to produce the measured excursions of the style observed by the microscope were measured by Weber's multiplication method. A tone of 440 vibrations producing an amplitude of 1 mikron indicated a current of 0·0000792 and produced an audible sound in the telephone. Bosscha speaks of the great sensitiveness of the telephone, and remarks that it can be used in observations upon the stratification noticed in Geissler tubes.—*Beiblätter Physik und Chemie*, ii, 513. J. T.

14. *On the hypothesis of a change of climate through changes in the obliquity of the ecliptic, or changes in the position of the axis of rotation.* The following remarks on this subject are cited from a paper by Dr. James Croll, entitled Cataclysmic theories of Geological Climate, which has appeared in the September number of the Geological Magazine (London).—The theory of a change in the obliquity of the ecliptic has been appealed to, in order to account for changes in geological climate. This theory for a time met with a favorable reception; but, as might have been expected, it was soon abandoned. The researches of Mr. Stockwell of America, and of Mr. George Darwin and others in this country, have put it beyond doubt that no probable amount of geographical revolution could ever have altered the obliquity to any sensible extent beyond its present narrow limits. It has been demonstrated, for example, by Mr. George Darwin, that supposing the whole equatorial regions up to latitude 45° north and south were sea, and the water to the depth of 2,000 feet were placed on the Polar regions in the form of ice—and this is the most favorable re-distribution of weight possible for producing a change of obliquity—it would not shift the Arctic circle by so much as half an inch!

Variations in the obliquity of the ecliptic having been given up as hopeless, geologists and physicists are now inquiring whether the true cause may not be found in a change in the position of the earth's axis of rotation. Fortunately this question has been taken up by several able mathematicians, among whom are Sir William Thomson,* Professor Haughton,† Mr. George Darwin,‡ the Rev. I. F. Twisden§ and others, and the result arrived at

* British Association Report, 1876, part II, p. 11.
† Proceedings of Royal Society, vol. xxvi, p. 51.
‡ Transactions of Royal Society, vol. clxvii, part I.
§ Quarterly Jour. of Geological Society, Feb., 1878.

ought to convince every geologist how hopeless it is to expect aid in this direction.

Mr. George Darwin has demonstrated that in order to displace the pole merely 1° 46′ from its present position, one-twentieth of the entire surface of the globe would require to be elevated to a height of 10,000 feet, with a corresponding subsidence in another quadrant. There probably never was an upheaval of such magnitude in the history of our earth. And to produce a deflection of 3° 17′ (a deflection which would hardly sensibly affect climate), no less than one-tenth of the entire surface would require to be elevated to that height. A continent ten times the size of Europe elevated two miles would do little more than bring London to the latitude of Edinburgh, or Edinburgh to the latitude of London. He must be a sanguine geologist indeed who can expect to account for the glaciation of this country, or for the former absence of ice around the poles by this means. We know perfectly well that since the glacial epoch there have been no changes in the physical geography of the earth sufficient to deflect the pole half a dozen of miles, far less half a dozen of degrees. It does not help the matter much to assume a distortion of the whole solid mass of the globe. This, it is true, would give a few degrees additional deflection of the pole, but that such a distortion actually took place is more opposed to geology and physics than even the elevation of a continent ten times the size of Europe to a height of two miles.

Mr. Twisden, in his valuable memoir referred to, has shown even more convincingly how impossible it is to account for the great changes of geological climate on the hypothesis of a change in the axis of rotation. This conclusion has been further borne out by another mathematician, the Rev. E. Hill, in an article in the June number of the Geological Magazine. And Professor Haughton, in a paper read before the Royal Society, April 4th, and published in Nature, July 4th, entitled "A Geological Proof that the changes of climate in past times were not due to changes in the position of the Pole," has proved from geological evidence that the pole has never shifted its position to any great extent. "If we examine," he says, "the localities of the Arctic regions and consider carefully their relations to the position of the present North Pole, we find that we can demonstrate that the pole has not sensibly changed its place during geological periods, and that the hypothesis of a shifting pole (even if permitted by mechanical considerations) is inadmissible to account for changes in geological climates."

There is no geological evidence to show that since Silurian times the Atlantic and Pacific were ever in their broad features otherwise than they are now—two immense oceans separated by the Eastern and Western continents—and there is not the shadow of a reason to conclude that the poles have ever shifted much from their present position. On this point I cannot do better than quote the opinion recently expressed by Sir William Thomson.

"As to changes of the earth's axis, I need not repeat the statement of dynamical principles which I gave with experimental illustrations to the Society three years ago; but may remind you of the chief result, which is that, for steady rotation, the axis round which the earth revolves must be a principal axis of inertia,' that is to say, such an axis that the centrifugal forces called into play by the rotation balance one another. The vast transpositions of matter at the earth's surface, or else distortions of the whole solid mass, which must have taken place to alter the axis sufficiently to produce sensible changes of the climate in any region must be considered and shown to be possible, or probable, before any hypothesis accounting for changes of climate by alterations of the axis can be admitted. This question has been exhaustively dealt with by Mr. George Darwin in a paper recently communicated to the Royal Society of London, and the requisitions of dynamical mathematics for an alteration of even so much as two or three degrees in the earth's axis in what may be practically called geological time, shown to be on purely geological grounds exceedingly improbable. But even suppose such a change as would bring ten or twenty degrees of more indulgent sky to the American Arctic Archipelago, it would bring Nova Zembla and Siberia by so much nearer to the pole: and it seems that there is probably as much need of accounting for a warm climate on one side as on the other side of the pole.* There is, in fact, no evidence in geological climate throughout those parts of the world which geological investigation has reached, to give any indication of the poles having been anywhere but where they are, at any period of geological time."

In the memoir from which the preceding paragraph is quoted, Sir William maintains that an increase in the amount of heat conveyed by ocean currents to the Arctic regions, combined with the effect of clouds, wind and aqueous vapor, is perfectly sufficient to account for the warm and temperate condition of climate which have prevailed during the Miocene and other periods.

Now this is the very point for which I have been contending for upward of a dozen of years. The only essential difference between Sir William's views and my own is simply this: he accounts for an increase in the flow of warm water to the Arctic regions by a submergence of the circumpolar land, whereas I attribute it to certain agencies brought into operation by an increase in the eccentricity of the earth's orbit.

15. *Cause of the cold of a Glacial era;* by JAMES CROLL, (Ibid).—When the eccentricity of the earth's orbit is at a high value and the northern winter solstice is in perihelion, agencies are brought into operation which make the southeast trade winds stronger than the northeast and compel them to blow over upon the northern hemisphere as far probably as the Tropic of Cancer. The result is that all the great equatorial waters of the ocean are

* This has been proved to be the case by Professor Haughton, in his paper to the Royal Society; "Nature," July 4, 1878.—J. C.

impelled into the northern hemisphere, which thus, in consequence of the immense accumulation of warm water, has its temperature raised, and snow and ice to a great extent must then disappear from the Arctic regions. When the precession of the equinoxes brings round the winter solstice to aphelion, the condition of things on the two hemispheres is reversed, and the northeast trades then blow over upon the southern hemispheres, carrying the great equatorial currents along with them. The warm water being thus wholly withdrawn from the northern hemisphere its temperature sinks enormously and snow and ice begin to accumulate in temperate regions. The amount of precipitation in the form of snow in temperate regions is at the same time enormously increased by the excess of evaporation in low latitudes resulting from the nearness of the sun in perihelion during summer.

The final result to which we are, therefore, led is, that those warm and cold periods which have alternately prevailed during past ages, are simply the great secular summers and winters of our globe, depending as truly as the annual ones do upon planetary motions, and like them also fulfilling some important ends in the economy of nature.

16. *Scientific Memoirs; being Experimental Contributions to a Knowledge of Radiant Energy.* By JOHN WILLIAM DRAPER, M.D., LL.D., President of the Faculty of Science in the University of New York, etc. Large 8vo, 473 pp. New York, 1878. (Harper & Brothers.)—The life of Dr. Draper has been an exceedingly busy one. For a period of more than forty years, in addition to his extended literary labors, he has devoted himself to experimental research with a rare success, and has in consequence been a prominent contributor to the development of many of the most important discoveries of modern science. Of the many scientific papers which he has published, he has collected together in the volume before us only those which relate to his investigations in radiant energy. This action is fully justified not only by the exceptional importance just now of this department of physics, but also because the American Academy of Arts and Sciences at Boston has recently individualized Dr. Draper's share in its evolution by awarding him the Rumford gold medal, and thus placing him on the illustrious roll of those who have made important discoveries relating to light or heat; a roll on which are the names of Hare, Ericsson, Treadwell, Alvan Clark, and Corliss. To particularize individual discoveries in a book, where there are so many and where all are so good, is by no means an easy task. Dr. Draper's investigations on the temperature of incandescence, and on the character of the light emitted at different temperatures (1847); on the photographic process, in the course of which he took the first photograph ever taken of the moon and of the human face as well as the first micro-photograph (1840); on the spectrum, both prismatic and diffraction, in which the distribution of energy was determined and the foundation laid for spectrum analysis (1857, 1872); on phosphorescence and the effect of heat on it

(1851); on the decomposition of carbonic acid by plants, in which the luminous rays were proved to be the active ones, and not the chemical rays (1843); on the chlor-hydrogen photometer, for measuring the intensity of the chemical radiations (1843); on the phenomena of capillarity, including their electrical aspect (1834–1845); and on thermo-electricity (1840); all these are researches of the highest order. In cases where the importance of the memoir seemed to require it, the publication of it has been in full. In other cases only in abstract; though the fullest references to the original paper are always given. Although we have in this volume a record of the investigations of but a single individual, and these only in a single direction; and although many of the original memoirs have been condensed, in some cases being barely mentioned, yet the results make a goodly volume of 473 pages. In thus collecting together the valuable work which he has accomplished, Dr. Draper has not only done an important service to American science, and produced a book of which it may be proud, but he has placed all students of radiant energy under obligation to him, since they now have these most important memoirs in a form convenient for constant reference and consultation. In his preface, the author hints that the still larger collection of memoirs on chemical, electrical and physiological topics, some of them as yet unpublished, may be the subject matter of a future volume. We sincerely hope that he may be induced before long, to undertake the work of preparing such a volume, and thus to leave on record in a permanent and complete form, the results of his extensive labors in science. The book is issued in handsome style, and has an excellent steel plate likeness of Dr. Draper as a frontispiece.

17. *Elements of Dynamic, an introduction to the study of Motion and Rest in solid and fluid bodies;* by W. K. CLIFFORD. Part I. Kinematic. 8vo, 221 pp. Macmillan & Co.—This book differs so much from the usual works on the same subject that it deserves special notice. A difference of minor importance is to be seen in the title, namely the dropping of the final *s* in the words Dynamics, Kinematics, Statics, &c. There is a free use with technical definitions of Saxon words, as *step*, *spin*, *twist*, *squirt*, *whirl*, &c. To the following extent quaternions are tacitly introduced. Vectors with their sums and fluxes are defined and used. The scalar and vector products of two vectors are treated as separate products, not as parts of a single one. The quotient of vectors is not used at all.

The following is the definition of *force* (p. 2). "It is found that the change of motion of any body depends partly on the position of distant bodies, and partly on the strain of contiguous bodies. Considered as so depending, the rate of change of motion is called *force*." That this definition does not fairly express the meaning of the word as good writers have heretofore properly used it may be seen by trying to put *rate of change of motion* for *force* in their sentences. For instance, Newton's first two laws of motion

assume a strange form with such treatment. It may be desirable, especially in pure Kinematics, to have a term to express that change of motion which *measures* force. But if so, is it not a fair demand that some new word be taken or coined for the purpose? The word force has been already used in too many different senses.

This book is called *Elements*, and it is really elementary, even though in some parts, owing to its terseness, it is not very easy reading. It is certainly the most suggestive book we know of on the subject. H. A. N.

18. *Sound: a series of simple, entertaining and inexpensive experiments in the Phenomena of Sound, for the use of students of every age;* by ALFRED M. MAYER, Professor of Physics in the Stevens Institute of Technology, etc. 179 pp., 12mo. New York, 1878. (D. Appleton & Co.)—This is number two of the "Experimental Science Series for Beginners," of which the first volume, upon Light, has already been noticed in this Journal. The object of the volume is to present the leading phenomena of sound in a simple and entertaining manner, by the use of such materials as are almost everywhere at hand, and with apparatus which any ingenious student can construct for himself. To present the elements of an abstruse subject in such a way as to make the exposition easily comprehensible by a mind not specially trained in it, and at the same time correct and satisfactory from a scientific point of view, is one of the most difficult undertakings in the work of an instructor. Add to this the task of bringing the experimental illustration of a science like that of acoustics, which requires such refinement in the apparatus and its manipulation, within the resources of everyone, and we have the difficulty very greatly increased. Professor Mayer's well-known experimental skill has enabled him to accomplish the work in an admirable manner, and he has laid under obligation to him not only the student and the amateur experimenter, but the teacher, who will derive many valuable suggestions as to his own work from this little volume. The subject is arranged in a very clear and methodical manner, and treated in a vivacious and entertaining style. The experiments, many of which are novel, unite extreme simplicity with elegance of conception and scientific precision, and cannot fail to interest and stimulate the minds of the students into whose hands the volume may fall. The illustrations, which are numerous, are excellently done, and give the book a very attractive appearance. A. W. W.

19. *A Contribution to the History of Spectrum Analysis;* by G. F. BECKER. (Communicated.)—In all the historical notices which have appeared on the subject of Spectrum Analysis, there exists, so far as I am aware, absolutely no mention of an investigation which must be regarded as an essential step in the direction of that great invention, and one intimately connected with its ultimate development. This investigation was made by Bunsen, and communicated to Berzelius in a letter bearing the date

Aug. 7, 1844. The Swedish chemist reported it to the Stockholm Academy (Œfversigt af kongl. Vet. Akad. Förh., (1844) i, 144,) and reprinted his report in his well-known "Jahresbericht über die Fortschritte der Chemie," (1845) xxv, 20. Translated the report reads as follows:—"Bunsen states, that the electric discharge between copper poles is blue, and that it shows the Fraunhofer lines beautifully, when observed by help of a tube through a prism. When other metals are employed, these lines are exhibited very differently and in marvellous variety. By throwing the image on a white wall by means of a *camera obscura*, the phenomena can be followed with the greatest exactness."

There is certainly no lack of clearness in this description, yet every one whom the subject interests will be glad to read the following translated extract from a letter written in answer to my inquiries, and dated 28th July, 1878. Bunsen writes:—"When I made that communication to Berzelius, more than thirty years ago, I regarded these lines, as did every one at the time, as a consequence of the lack of certain kinds of light in the sources of light. In writing that the electric discharge between metallic poles 'showed the Fraunhofer lines wonderfully well,' I can therefore at that period have referred only to the dark lines between the bright ones, and by no means to the reversed, bright and true Fraunhofer lines. This is sufficient to show that, in the observations made at that time, I had as little idea as any one else at the period, of the fundamental constancy of the lines of glowing gases, to say nothing of any suspicion of the transformation of bright lines into dark ones."

It is superfluous to predict that others will ascribe to this research a very different degree of importance from that indicated by the investigator who made it.

II. Geology and Mineralogy.

1. *Oil-well Records in the Northern or Bradford Oil regions, Pennsylvania.*—A paper by C. A. Ashburner, of the Geological Survey of Pennsylvania, published in the Proceedings of the American Philosophical Society, contains records of recent well-borings in McKean and Elk Counties, the Northern or Bradford oil-regions. Among them, that of the well of Dennis & Co., in the former county, to the southwest of Bradford, is of special interest on account of the exact register it gives of the kinds of beds passed through by the drill. A complete description of the rocks will be published in Mr. Ashburner's forthcoming Report of Progress. The elevation of the top of the well above sea-level is 2,055 feet; and the rock about the mouth is the Olean conglomerate, or the bottom of the Millstone grit, called the Coal conglomerate, No. XII, in Pennsylvania geology. Its depth is 1,719 feet. The boring took place in December, 1877 and January, 1878, and the record, which was kept by Mr. Arthur Hale, aid to J. F. Carll, Assistant Geologist in the Geological Survey, is the longest *de-*

tailed and accurately measured record of any oil-well in the United States. The oil-producing sand (sandstone) belongs to the Chemung period, or the upper part of No. VIII. in Pennsylvania geology. A letter to the editors from Mr. Ashburner contains the following statements respecting it. One object in view was to determine the exact stratigraphical relations between the "Third oil-sand" along Oil Creek, Venango Co., and the producing oil-sand at Bradford. Mr. Carll ascertained, in 1875, that the two were different, and that the former was stratigraphically several hundred feet above the latter. In his Report of Progress, the top of the Oil Creek "Third sand" is stated to be about 750 feet below the bottom of the Second Mountain sand, which is probably the equivalent of the Olean conglomerate in my records. The Bradford producing sand is 1,780 feet, more or less, below this latter horizon, so that if the measures neither increase nor diminish in thickness between Bradford and Oil City, the Bradford producing sand would be about 1,000 feet below the "Third sand" along Oil Creek. We are sure that the rocks maintain a constant thickness between these two points.

The paper of Mr. Ashburner gives the records also of the Kinzua Well, 1,768 feet deep; the Wilcox Well, No. 2, or Schultz Gas Well, 2,004 feet deep; the Wilcox Well, No. 3, 1,808 feet deep; the Ernhout and Taylor Wells, Nos. 1 and 2, the latter 2,000 feet deep; the Bear Creek Well, 1,998 feet; the Silver Creek Well, 1,760 feet.

It states, concerning the Schultz Gas Well, that gas issued in immense quantities from a depth of 1,776 feet. An inch pipe was inserted to a depth of 2,000 feet, and the mouth of the well closed with the hope of causing the gas to force out the oil from the latter depth. Two or three barrels of oil were thus obtained; and if, as Mr. Schultz believes, the tube was entirely filled with the oil, the pressure of the gas was sufficient to raise a column of oil an inch square in section and 2,000 feet high. This great pressure was sustained but for a few moments; the gas probably became thoroughly mixed up with the oil, which from its low temperature quickly congealed and effectually choked the pipe." After a few hours the gas ceased entirely; but after thirty-six hours, it commenced to flow again with great energy. There was a sudden increase of the pressure in the early part of 1877. Four months later the flow of gas ceased, but in July 14th it began again to flow; and "up to the present time the amount of gas increases and diminishes at irregular intervals." The gas was used in drilling the Wilcox Well, No. 3.

2. *Region of the Great Lakes.*—Mr. George Maw, F.L.S., mentions (Geol. Mag., Oct., 1878) facts connected with the level and depth of the Great Lakes, and of glacial phenomena about them, (stating, among other things, that the bottom of Lake Ontario is 365 feet below the sea-level and 600 feet below its own outlet into the St. Lawrence; of Erie, 462 feet above the same; of Huron, 145 feet above; of Lake Superior, 65 feet below the

sea-level); and concludes that the idea of the excavation of Ontario to a depth of 600 feet by glacier action is wholly untenable, and that the theory of glacial excavation for the chain of large lakes must be set aside, in which he is plainly right; and he concludes that *the lake depressions are of post-glacial origin.*

3. *On the occurrence in North America of rare Extinct Vertebrates found fragmentarily in England.*—Professor R. Owen has a paper with this title in the Annals and Magazine of Natural History for September, 1878. It treats first of the "Restoration of *Chondrosteosaurus*," to which he refers Cope's *Camarosaurus*, and secondly of the Restoration of *Coryphodon*. In the remarks on the latter genus, first established by Professor Owen, the author brings out many points of interest, and gives credit to Professor Marsh's discoveries for the chief part of the facts upon which they are based. The paper has the following concluding sentence. "To the close and careful comparisons of the conscientious palæontologist of Yale College, we are indebted for the above interesting and unexpected additions to our knowledge of the rare and ancient Tertiary mammal, fragmentarily indicated in the 'plastic clay' of England (1845) and in the 'conglomérate de l'argile plastique' at Mendon, France (Hébert, 1856), of the elements toward a restoration of which we might have long remained in doubt had they continued to be made known to us as parts of a *Bathmodon* or *Loxolophodon*."

4. *On the Erupted Rocks of Colorado;* by J. M. Endlich. 572 pp., 8vo. From the 10th Annual Report of the United States Geological Survey under Dr. F. V. Hayden, United States Geologist-in-charge.—Mr. Endlich classifies and describes the eruptive rocks of Colorado, their relation to the veins of ore, their age and origin.

5. *Analyses of Saussurites.*—The following are the references for the analyses cited on page 341.—1. T. S. Hunt, this Journal, II, xxvii, 345, 1859; 2, Fikenscher, J. pr. Chem., lxxxix, 456, 1863; 3, Hütlin & Pfaffius, Verh. Ges. Freib. im Br., ii, 1861; 4, Delesse, Bull. Soc. Geol. de France, II, vi, 547, 1849; 5, of a specimen from Neurode, Silesia, Vom Rath, Pogg. Ann., xcv, 555, 1855; 6, C. F. Chandler, Inaug. Dissert. Gött., 1856 (from Zobten, Silesia); 7, 8, of a lavender-blue variety, in euphotide of the Isle of Unst, M. Foster Heddle, Min. Mag., Truro and London, April, 1878; 9, Delesse, Ann. d. Mines, IV, xvii, 116, 1850; —10, Damour, C. Rend., lvi, 861, 1863; 11, L. R. Fellenberg, Nat. Ges. Bern., 1865, 112; 12, of a saussurite hatchet from near Gerlafingen on Bieler See, Switzerland, Fellenberg, Verh. d. Schweiz. Ges. Solothurn, 1870 (G.=3·2978).

The analysis of the Orezza saussurite by Boulanger appeared in the Ann. des Mines, III, viii, 159, 1835; he obtained SiO_2 43·6, AlO_3 32·0, MgO 2·4, CaO 21·0, K_2O 1·6=100·6. He also analyzed a saussurite from Mt. Genèvre, obtaining SiO_2 44·6, AlO_3 30·4, MgO 2·5, CaO 15·5, Na_2O 7·5=100·6, showing an approximation to Delesse's results and a composition near that of

labradorite; but G.=2·65; it was therefore in the feldspar, and not the saussurite, state. The occurrence of labradorite and saussurite in a euphotide, and transitions from one to the other, appear to be not uncommon.

An analysis of a saussurite from euphotide in Norway near Bergen, afforded Th. Hjortdahl (Nyt. Mag. Nat. Christiania, and Groth's Zeitschr., 1878, 305), SiO_2 42·91, AlO_3 31·98, FeO 0·19, MgO 0·81, CaO 20·94, Na_2O 2·32, K_2O 0·18=99·33, with G.=3·19. It differs little from other analyses of saussurite of the *first* kind, or true saussurite, excepting in the small amount of magnesia.

Although jadeite is not yet known to be one of the euphotide minerals, the specimens being thus far only polished implements or ornaments, its analyses are of interest in this connection, and the following are here added:

	1. Morbihan.	2. Emerald-green.	3. Thibet.	4. Red, China.
SiO_2	58·62	59·66	58·28	60·22
AlO_3	21·77	22·86	23·00	22·58
CrO_3	----	0·14	----	----
FeO	1·86	0·42	4·94	1·59
MnO	0·28	----	*trace*	0·65
MgO	2·23	2·41	1·04	1·15
CaO	3·85	2·27	3·06	1·53
Na_2O	11·64	12·87	9·23	12·60
K_2O	----	----	*trace*	----
Ign.	----	----	----	0·11
	100·25	100·63	99·55	100·70
	G.=3·344	G.=3.330	G.=3·25	G.=3·3456

Nos. 1 and 2 are by Damour, C. Rend., lxi, 1865, p. 361; 3, by Fellenberg, Verh. d. schweiz. Ges. Solothurn, 1870; 4, Eckstein, in H. Fischer's work entitled "Nephrit und Jadeit," Stuttgart, 1875, p. 375.

Th. de Saussure's paper in which he gave the name *Saussurite* to the "Jade" which his father had described (in his Voyages dans les Alpes, i, §112 and v, §1313) is contained in the Journales des Mines, xix, 206, 1806. Further study will probably result in dividing up euphotide according to the kind of saussurite present.

J. D. D.

6. *On Leucoxene in the New Hampshire Diorites;* by G. W. Hawes. (From Mr. G. W. Hawes's Report on the Mineralogy and Lithology of New Hampshire.)—In this Journal, volume xii, at page 134, I described certain reticulated appearances in the "Greenstones" of New Hampshire, as probably of organic origin. These forms were the result of a species of decomposition to which titanic iron is peculiarly subject, and the structure was produced by the cleavage or lamination of the mineral. The product of the decomposition is a grayish white substance, the composition of which is not well established. It was called leucoxene by Gümbel. Sandberger and von Lasaulx regard it as a lime titanate, which results from a reaction between the titanic acid and the lime of the hornblende and feldspars. Cohen suggests that it is pure titanic acid, which view is favored by Rosenbusch. But whatever the substance may be proved to be, the forms observed are the result of the decomposition of titanic acid.

7. *The association of Pyroxene and Hornblende;* by G. W. HAWES. (From Mr. G. W. Hawes's Report on the Mineralogy and Lithology of New Hampshire.)—Though any material capable of forming pyroxene may, under other circumstances, crystallize in the form of hornblende, yet when the two species are so associated as to indicate their formation under the same circumstances, chemical composition must determine the species. This intimate association of the two minerals is frequent in certain eruptive rocks, and some New Hampshire diorites furnish very marked examples in which both species are well crystallized.

The following analyses of associated pyroxene and hornblende from Edenville, N. Y., at which place material in a state of purity can be obtained for analysis, were made for the purpose of discovering what chemical differences had affected the crystallization. The following were the results:

	Hornblende.	Pyroxene.
Silica	42·97	51·05
Alumina	11·90	2·02
Iron sesquioxide	3·08	1·30
Iron protoxide	13·84	12·18
Manganese protoxide	·48	·12
Magnesia	11·49	10·02
Lime	11·63	22·07
Soda	2·73	----
Potash	·88	----
Ignition	·38	·34
	99·38	99·10

The association of pyroxene and hornblende has been noticed by vom Rath in the Vesuvian lavas, where they were formed by sublimation. (See Pogg. Ann. Band Ergänzung, vi, 229.) The analyses were imperfect on account of the small amount of material, but it is interesting to observe that they show the same differences; that is, the hornblende contains a larger percentage of alumina, a smaller of lime, and some alkali which is absent in the pyroxene.

8. *Die Mineraliensammlung der Kaiser-Wilhems-Universität Strassburg, ein Supplement zu den vorhandenen mineralogischen Handbüchern* von P. GROTH. 271 pp. 4to, with six plates. Strassburg, 1878 (Karl J. Trübner).—Professor Groth, during his six years' connection with the University at Strassburg, has succeeded in bringing together a mineralogical collection which ranks very high both as regards the number of specimens and their individual excellence. The catalogue which he has recently published contains the results of a very minute study of the collection, giving a description of each specimen with its locality and a determination of the form when crystallized. The work contains much that is new and valuable, and in some cases, as for instance manganite, the description is in fact a monograph of the species giving, many new planes with a large number of figures. The volume is thus a valuable contribution to mineralogical literature. E. S. D.

9. *Mineralogische und Petrographische Mittheilungen*, herausgegeben von G. TSCHERMAK. New series, vol. i, Vienna, 1878.—The "Mineralogische Mittheilungen," which, under the editorship of Professor Tschermak, have appeared since 1871 in connection with the publications of the Austrian "Geologische Reichsanstalt, have occupied an important place among mineralogical publications. With the present year a new series has been commenced, and in future the Journal will be published independently in yearly volumes of six numbers each. Its scope is at the same time enlarged both as regards original articles, and in the summary given of mineralogical work published elsewhere, which forms an important part of each number. Its usefulness will be much increased by the change. E. S. D.

10. *Brief notices of some recently described minerals:*—

Friseite. Occurs in dark-brown orthorhombic crystals with perfect basal cleavage; translucent and sectile. H.=2–3, G.=4·217. An analysis gave S 37·4, Ag 29·1, Fe 33·0=99·5, for which the formula $Ag_6Fe_{12}S_{26}$ is obtained. It is very closely related to sternbergite both in crystalline form and in composition, and the propriety of giving it a new name may well be questioned. Locality, Joachimsthal in Bohemia.—(Vrba, Zeitschrift für Krystallographie, ii, 153).

Hibbertite. Occurs as a loose powder of a lemon yellow color imbedded in purple kammererite. The percentage composition obtained for it after the deduction of the kammererite, from which it could not be entirely separated, is as follows:—CaO 28·46, MgO 26·55, FeO 3·23, MnO 0·58, CO_2 25·44, H_2O 15·73. The name is given only provisionally, as the character of the mineral is not yet established. Locality, Island of Unst (Shetland Isles).—(Heddle, Mineralogical Magazine, ii, 24).

Hullite. A soft velvet-black mineral, with a dull waxy luster. It occurs filling cavities in the basalt of Carnmoney Hill, near Belfast, Ireland. An analysis afforded:—SiO_2 39·43, AlO_3 10·35, FeO_3 20·72, FeO 3·69, MgO 7·47, CaO 4·48, H_2O 13·61, CO_2, MnO, *tr.* =99·77. It seems to be allied to delessite.—(Hardman, Nature, Sept. 5, 1878).

Stützite. Observed in lead-gray highly modified crystals on a specimen of gold from Transylvania (probably Nagyag). The crystals are referred to the monoclinic system, though the symmetry is closely that of the hexagonal system. Contains tellurium and a high percentage of silver, the composition being probably expressed by the formula Ag_4Te=tellurium 22·5, silver 77·5. The crystalline form is closely related to that of dyscrasite and chalcocite.—(Schrauf, Zeitschrift für Krystallographie, ii, 245.)

Pseudobrookite. Occurs in minute tabular crystals belonging to the orthorhombic system; cleavage brachydiagonal distinct. H.=6. G.=4·98. Color dark-brown to iron-black, but in the thinnest crystals brown to red, translucent. Luster adamantine. An analysis afforded TiO_2 52·74, FeO_3 (AlO_3 tr.) 42·29, CaO and MgO 4·28, ignition 0·70; according to this the mineral has the

same composition with menaccanite, from which it differs in crystalline form.—(Koch, Min. u. Petr. Mitth. i, 1877.)

Szaboite. Occurs in minute, exceedingly thin, triclinic crystals, which approach the form of pyroxene quite closely. H.=6 and above. G.=3·505. Color hair-brown, in some crystals brownish to hyacinth red; opaque to translucent. An analysis afforded:—SiO_2 52·35, FeO_3 44·70, (AlO_3 tr.), CaO 3·12, MgO, Na_2O tr., ignition 0·40. The mineral is more or less closely related to babingtonite.—(Ibid.) E. S. D.

11. *Geology of New Hampshire.*—The third volume of this Report, recently issued, contains the reports of W. Upham on drift, and of G. W. Hawes on mineralogy and lithology, already noticed, and also chapters on Glacial Drift and on Economic Geology, by C. H. Hitchcock.

The Atlas of the Survey has also appeared in seventeen sheets very large folio, giving the topography, views, profiles, sections, distribution of glacial phenomena, and maps of the geology as made out by the Survey. The coloring is well done.

The Atlas illustrates several interesting points in the geology of Northern New England. It shows that the region of Northern New Hampshire has *Lower Devonian* rocks (Oriskany and Helderberg) just east of its eastern boundary, near latitude 45°, south of Kennebago Lake, in Maine, the age of these rocks being proved by their fossils; that to the westward a degree and more, and just north of lat. 45° (45° to 45° 20′), east of and near Lake Memphremagog, there are also *Lower Devonian* rocks, fossil corals being abundant in calcareous beds which alternate with Helderberg slates that are equivalents of the Gaspé sandstone; and that between these fossiliferous areas of the eastern and western borders of New Hampshire, over Coös County, there are broad, parallel, nearly north and south, belts of "Calciferous mica-schist," the "Coös group," the "Lyman group" and the "Lisbon group," besides strata of clay slate.

The Atlas also shows that the usually associated Calciferous mica-schist and Coös group extend from the Lake Memphremagog region, southward, along the Passumpsic and Connecticut River Valleys, the western border of New Hampshire, to and beyond the southern extremity of the State; that in the Connecticut valley, one-third of the way to the south extremity, at Littleton and Lisbon, there occurs a *Lower Helderberg* (Upper Silurian) limestone, semi-metamorphic, whose age is determined by its fossil corals and brachiopods, and near by are Coös, Lisbon and Lyman beds; and at the south extremity of the State, just west of the southwest angle, there is again *Lower Helderberg* limestone—that of Bernardston—the semi-metamorphic beds of which contain large crinoidal remains.

The writer's observations prove that the Bernardston limestone group* embraces, within a few miles northeast of Bernardston,

* See this Journal, III, xiv, 379, 1877.

mica and hornblende schists, staurolitic schist, quartzyte and other rocks, all lying conformably and alternating with one another; and that these rocks are similar in lithological character to the mica and hornblende schists and quartzyte of the valley to the north; and, that part of them, as Professor Hitchcock asserts, are identical with his Coös slates, indeed, so closely identical that the Bernardston mica schist is made by him Coös. The latter has stated also that the Calciferous mica schist belongs with the Coös.

In view of these facts there is little reason to doubt (1) that the region of New Hampshire in its large northern portion across from east to west is of Lower Devonian and Silurian age; (2) that south of Lake Memphremagog, along the Passumpsic and Connecticut valleys down to Massachusetts (if not farther), the rocks are of Lower Helderberg age and perhaps partly of Lower Devonian; that thus New Hampshire has Paleozoic formations not older than Upper Silurian on its northeastern, northern, and all its western borders; and that the White Mountain region occupies the space between,—Mt. Washington being not twenty miles east of Littleton. These conclusions are those of Sir William Logan's geological map.*

As to the geological age of the region of the White Mountains and that south of it, the map gives nothing definite. Professor Hitchcock's report, (the closing pages of vol. II)† makes the Bethlehem gneiss, the Lake Winnipiseogee gneiss and the porphyritic gneiss, Laurentian; the Montalban schists (mica schists, etc., of the White Mountain region) Upper Laurentian; and the Lyman and Lisbon groups, and the hornblende schist formation, Huronian. In the east-and-west section across the State between the parallels of 44° and 44° 10′, published on one of the geological maps of the Atlas, the Bethlehem gneiss (so-called Laurentian) is shown to be *conformable* in its bedding to the Lisbon Group; and the latter, conformable to the Coös and Calciferous mica schist. Again in a section running across between the parallels 43° 50′ and 44°, the Lake Winnipiseogee and Bethlehem gneiss are conformable to one another and to the staurolitic schists of the Coös, and the latter to the Calciferous mica schist. Again, in a section between the parallels 43° 40′ and 43° 50′ the Montalban schists and Bethlehem gneiss are conformable, and the latter is made conformable in Moose Mountain with the staurolite schists of the Coös; and east of Hanover, this conformability is repeated, and the Coös is made conformable with the Hornblende schist, Lisbon group, clay slate, Calciferous mica schist, and the Coös farther west. Thus there is no evidence in the stratification, according to these sections, that the so-called Laurentian and Huronian are any older than the Coös and Calciferous mica schist of the Connecticut valley;

* The statement on some of the maps—"Sillery, Lauzon, Lewis: Logan's arrangement of the Upper Huronian in Canada and Vermont," is misleading to those not familiar with the facts, since Logan made these formations "*Lower Silurian*," and not "*Upper Huronian*;" and Mr. Hitchcock meant to say Logan's subdivisions of what he *himself* refers to the Upper Huronian.

† This Journal, III, xiv, 316.

and therefore, whether Laurentian, Huronian, or whatever the age, the sections afford nothing to sustain the conclusions as to age, based on the lithological characters of the rocks, put forth in Professor Hitchcock's Report. The evidence, as it stands, is strongly in favor of making the Coös and Calciferous mica schist, with the Lisbon and Lyman groups and the Hornblende schist, of the age of the Lower Helderberg, if not also partly Upper Helderberg. It leaves the age of the gneissic rocks wholly undetermined. There is as yet no good evidence as to the existence, or not, of Laurentian or Huronian rocks in New Hampshire. J. D. D.

12. *Manual of Mineralogy*, by JAMES D. DANA.—A new, and mostly rewritten, edition of this small Manual of Mineralogy will be published by Wiley & Sons, New York, in November.

III. BOTANY AND ZOOLOGY.

1. *Ueber apogame Farne und die Erscheinung der Apogamie im allgemeinen;* by A. DE BARY. *Botanische Zeitung*, July 19th, 1878, et seq.—The article bearing the above title contains the substance of the address made by Professor De Bary at the annual meeting of German naturalists held in Munich in the autumn of 1877, and the results of his observations on the non-sexual reproduction in ferns as first described in the Botanische Zeitung of 1874. In the last named paper [by Dr. Farlow], it was shown that, in some cases, the prothalli of *Pteris Cretica*, instead of the usual growth from a fertilized archegonium-cell, produced ordinary buds, from which the new fern plant developed without any sexual action whatever. The observations now published by Professor De Bary were made with the intention of ascertaining more in detail the frequency with which the non-sexual mode of reproduction occurred in ferns, and its relation to similar processes in other groups of the vegetable kingdom. He found, on sowing the spores of *Pteris Cretica*, obtained both from cultivated plants of that species and from forms which grew wild in Italy, that, in all cases, the prothalli produced only the non-sexual buds to which he gives the name of "Farlowsche Sprossung." In the few cases where antheridia, archegonia, and the normal embryonic development apparently occurred, he found, by watching the further development of the fern, that the prothalli were not those of *Pteris Cretica*, but came from the spores of other species which had accidentally found their way into the cultures. Of the different species studied by De Bary, in thirty-four, exclusive of varieties, only the normal development by embryo-formation in the central cell of the archegonium was observed; in three, *Aspidium Filix-mas*, var. *cristatum*, *Aspidium falcatum*, and *Pteris Cretica*, only the non-sexual budding. The prothalli of *Pteris Cretica* may or may not contain antheridia. When present they have the same structure as in the typical *Polypodiaceæ*. In by far the majority of cases there are no traces of archegonia, even in a rudimentary condition. Out of hundreds of cases, only seven were found with archegonia, and they all aborted. *Aspidium Filix-mas* per-

fectly resembles *Pteris Cretica* in the distribution of antheridia and archegonia, but in *Aspidium falcatum* archegonia occurred in at least 25 or 30 per cent of the prothalli. Although in the cases observed they had all aborted, De Bary thinks it possible that cases may occur in which the normal embryo-formation takes place, which is hardly possible in the two species first named.

The budding process, in all three cases, consists in the formation of a protuberance on the under surface of the prothallus, from which grow a first leaf, root, and stem-bud, as in the normal embryo-formation, although their relative position and date of development varies. The protuberance is generally found just back of the sinus, where the fertilized archegonium normally occurs. Variations were seen in which the first leaf grew from the upper surface of the prothallus and, at times, two leaves were produced, one on the upper and one on the lower surface. Secondary forms may be produced upon elongations of the lateral lobes of the prothallus. Some of the more peculiar forms are figured in the plate which accompanies the article. In the three species under consideration, as the normal reproduction by an embryonal growth has been lost, and another, non-sexual form of reproduction has taken its place, we may infer that they have descended from some ancestral form in which the sexual mode of reproduction existed. This is illustrated by the case of *Aspidum Filix-mas*, var. *cristatum* which is undoubtedly derived from the typical *Aspidium Filix-mas*, in which only sexual reproduction is known. If, however, we adopt the view recently advanced by Pringsheim, that ferns were originally composed of "Bionten," some of which were sexual and some non-sexual, and which alternate, more or less regularly with one another, we must consider that, instead of having acquired a new power, the ferns which reproduce by budding represent a case of atavism.

De Bary gives the name of *Apogamy* to this substitution of some other form of reproduction in cases where the power of sexual reproduction has been lost. This condition is found in all parts of the vegetable kingdom, and occurs in single species, or groups of species, whose nearest allies reproduce normally. Apogamy is of three kinds: *Apogeny*, where the function of both male and female organs is destroyed; *apogyny*, loss of reproductive power in the female, *apandry*, in the male organ.

Chara crinita is a good instance of apandry with parthenogenesis, that is, of regular embryo-formation from an unfertilized ovule. The female of this species is alone known in northern Europe, yet it fruits abundantly. It has been studied by De Bary in specimens artificially grown in his laboratory; and there is no doubt that here it is not a question of the partial suppression, but of the total loss of the male organs. In ferns we have the best instance of a substitution of a shoot for the normal sexual growth. To the same category belong some of the mosses usually called sterile, that is, destitute of capsular growths. In the mosses, however, it is a question not yet settled whether there is a total loss or only a partial suppression of sexual reproduction.

In *Funkia* and *Allium fragrans*, in the seeds in which Strassburger discovered adventive embryos, we have something similiar to the apogamous ferns; first, in the presence of apparently regularly formed but functionless female organs; secondly, in the presence of apparently active pollen, and thirdly, in the substitution of adventive embryos for the regular embryo-formation. *Citrus* and *Cœlebogyne*, in which Strassburger also found adventive embryos, probably belong to the same class as *Allium* and *Funkia*, as may, also, species like *Euonynuss latifolius*, many *Ardisiæ*, etc., in which polyembryony often occurs. To these are to be added the numerous species, varieties, and races of cultivated plants which rarely produce seeds, but instead have a correspondingly richer reproduction by shoots. If, as seems tolerably certain, sexual reproduction is requisite to the constant propagation of species, we must regard apogamy as a degenerate condition, in which the conditions of propagation are unfavorable. In this connection, however, we must not overlook the fact that in species with budding or non-sexual reproduction, this offspring is produced in surpassing profusion. W. G. F.

2. Todaro, *Relazione sulla Cultura dei Cotoni in Italia, sequita da una Monograpia del Genere Gossypium.* Rome and Palermo, 1877–78. 287 pp. oblong 4to, with atlas of 12 colored plates in large folio.—This work is published apparently by the Italian Government, as an illustrative accompaniment to its exhibition of cotton at the Paris Exposition. In illustration of the species it rivals the monograph of the late Parlatore, though the atlas is not on so large a scale; and the letter-press is much more elaborate. Fifty pages are given to the account of Italian cotton culture; the remainder of the volume to a monagraph of Gossypium, and the history of the genus. Prof. Todaro's views of the species, and of the extent of the genus, may be gathered from the fact that he describes fifty-two species and mentions two other uncertain ones, under four sections, that he includes *Thurberia* under *Eugossypium*, and part of *Fugosia* as well as *Sturtia* under other sections. The former, under the name of *Gossypium Thurberi* Tod., is associated in a subsection, *Anomala*, with a Javanese and an African species, which combine the habit of Cotton with narrow involucral bracts. The author, indefatigable as he has been in compilation, was not aware of the identification of *Thurberia* with the obscure old genus *Ingenhousia;* but *I. triloba* is the same plant. A. G.

3. *The Native Flowers and Ferns of the United States in their Botanical, Horticultural, and Popular Aspects*; by Thomas Meehan, Professor of Vegetable Physiology to Pennsylvania Board of Agriculture, etc. Vol. I. Illustrated by chromolithographs. Boston: Prang & Co., 1878. 192 pp., plates 1–48.—The first volume of this work being now completed and the second doubtless in progress according to the programme, the success of the large undertaking apparently warranting further continuation, it seems due and proper to supplement our notice of the beginning

of the work (in vol. xv, p. 72 of this Journal) with a remark or two upon the completed volume. While congratulating the enterprizing publishers and the ardent editor upon their success, which ensures a full continuance of the publication, we shall, on this very account, freely offer any criticisms that may conduce to its improvement. "Flowers and Ferns in their horticultural and popular aspects" do not here concern us. We dismiss their consideration to the horticultural and the literary press. There is much to interest both, and the plates will interest and satisfy amateurs generally, and more critical botanists not rarely. But the botanical aspects are sometimes taken from a rather high point of view, and the same may be said of some of the botanico-etymological researches. While most may pass without grave dissent, there are morphological and etymological statements which we would be sorry to have set down as specimens of American culture. The morphological and other botanical points to which exception should be taken may pass with this simple *caveat*, as we have no room to discuss them, and to botanists whom we address there is little need. But there are two bits of philology in one number (the sixth) which it would be wrong to pass over, being very characteristic for a tendency to be "wise above what is written."

Sedum has by long prescription been thought to be derived from *Sĕdeo, sedere*, to sit, as on rocks. The editor of the work in hand devotes nearly two pages mainly to the reconsideration of this question, and comes to the conclusion that *sēdo*, to assauge, is the root of the name, Linnæus and the rest to the contrary notwithstanding. To be sure "the name is a very old one and was merely adopted by Linnæus, "who may be all wrong in philology. Still we botanists are not likely to know much better. Tournefort had indeed given his readers the choice of these two derivations; but he did not decide the question. Prof. Meehan decides for *sēdo*, and confirms the opinion by the statement that the *e* in *Sedum* is long. But the Latin dictionaries agree that it is short.

Limnanthemum is thought a badly named genus because its species grow in water rather than in mud or marsh. But the classical meaning of the first member of the word is a pool of standing water and a marshy lake. If "it is properly an aquatic," we should think it properly named. But "our species was named *L. lacunosum*, from the Latin *lacus*, a lake, by Grisebach, author of a Flora of the West Indies, from its actual place of growth, and it might be supposed as a corrective of its generic name. But there are in other countries more species that grow in lakes, so we see there is nothing distinctive in either name, and those therefore who might infer it to be so would be led into serious error." The danger of supposing that the name of a species founded on its place of growth indicates that it is the only species in such places, is not imminent. And only the very few can "be led into serious error" here who have first adopted the notion that *lacunosum* (full of *lacunæ* or pits, as in the lower face of the leaf) is an adjective of *lacus*.

A. G.

5. *Der Zoologische Anzeiger, of* J. V. CARUS.—The recent publication of the Zoological Record for 1876, of the Bericht of Leuckart for the years 1872–75 and of the first numbers of the Zoologische Anzeiger by Carus, naturally suggests an examination of our methods for recording progress in Zoology. We cannot expect either the Jahresberichte which have for so long a time formed one of the annual volumes of the Archiv für Naturgeschichte, or Hofman and Schwalbe's Jahresberichte, or the Zoological Record to appear early enough to be of immediate use to specialists in the course of their investigations. These reports necessarily date back so long that they can only be an indispensable compendium for the general worker who wishes to take up a special subject or see what has been done in the general field.

Some of the recorders have limited their task to a strict analysis of the publications issued within the time included in their record, while others have added to this a running commentary and a more or less favorable criticism. This seems somewhat superfluous, for we can scarcely expect any thing beyond the most limited "notice" in the space at the command of the recorders. In a review of the last Zoological Record in a late number of "Nature" the recorders are all taken to task for not giving greater prominence to Wallace's "Geographical Distribution." What any recorder can find to say in the space at his disposal, which the zoological student has not found out long ago from the work itself, it is difficult to see. And certainly the writer of the notice in Nature hardly expected zoologists to obtain their first information of its publication from the pages of the Zoological Record. The great difficulty under which we all labor is to obtain early information of the articles appearing in the publications of learned societies. These are now so numerous that the majority of our public institutions receive but a small proportion of what is annually published, and what they do receive is issued irregularly and is generally from six to eighteen months in reaching its destination, according to the distance from the point of publication. The question naturally arises: cannot a system be devised by which zoologists will be able to receive by mail early notice of all that is going on, and thus enable them to make special efforts to obtain what they most desire? The Zoologische Anzeiger of Carus seems to us to meet the case. If working naturalists will agree to send to Professor Carus the title of any paper they publish, the moment it is *printed*, giving in a few words also the table of contents and the usual details regarding the number of pages, plates, size, and place of publication, we may hope to be kept informed of all that is going on in Zoology without needless delay. And if Professor Carus could be induced to print the titles on one side of the page, these titles could then be cut up and arranged systematically or alphabetically or both, and no one need remain long in ignorance of what is doing by others. This would probably necessitate giving up the literary notices, but with the large number of zoological periodicals now issued it would not lessen the value of the Anzeiger. A. AG.

6. *Note on Borings of a Sponge in Italian Marble;* by A. E. VERRILL.—Some very interesting specimens were recently presented to the Peabody Museum of Yale College, by Dr. I. P. Trimble, of New York. These are fragments of white Italian marble, from a cargo wrecked off Long Island in 1871, and taken up this year. The exposed portions of the slabs are thoroughly penetrated to the depth of one to two inches by the crooked and irregular borings or galeries of the sponge, *Cliona sulphurea* V., so as to reduce it to a complete honey-comb, readily crumbling in the fingers. Beyond the borings the marble is perfectly sound and unalterd. The rapid destruction of the shells of oysters, etc., by the borings of this sponge has long been familiar to me,* but of its effects upon marble or limestone I have not before seen examples, for calcareous rocks do not occur along the portion of our coast which it inhabits. Its ability to rapidly destroy such rocks might have a practical bearing in case of submarine structures of limestone or other similar materials.

7. *Ophiuridæ and Astrophytidæ of the Challenger Expedition, Part I.* By THEODORE LYMAN. Bulletin of the Museum of Comp. Zoology, vol. v, No. 7. Cambridge. 104 pp. 8vo. 10 plates.—In this important contribution thirteen new genera and ninety-six new species are added to those families included in this part. This shows, very conclusively, that the Ophiuroids, as a group, are largely deep-water forms. The new species are well illustrated and described at length. The new genera are *Ophiomastus*, *Ophiopyrgus*, *Ophiocrinus*, *Ophiotrochus*, *Ophiophyllum*, *Ophiobyrsa*, *Ophiochiton*, *Ophiocamax*, *Ophiosciasma*, *Ophiogeron*, each with one species; *Ophioplinthus*, *Ophiopyren*, and *Ophiolebes*, each with two species. Of known genera, there are described of *Ophiocten*, 4 species; *Ophioglypha*, 35; *Ophiomusium*, 12; *Ophioceramis*, 1; *Ophiozona*, 4; *Ophioscolex* 2. v.

8. *Synopsis of the Pycnogonida of New England;* by EDMUND B. WILSON, Trans. Connecticut Academy of Arts and Sciences, vol. v, Aug. 1878. 26 pp. 8vo, 7 plates.—The North American Pycnogonida have hitherto received very little attention. In this paper fourteen New England species are described, of which five are new. Of the remainder, six are Greenlandic and North European species, and three were described by Dr. Wm. Stimpson from the Bay of Fundy. The genera represented are as follows: *Pycnogonum*, 1 species; *Tanystylum*, 1; *Achelia*, 1; *Pseudopallene*, 2; *Pallene*, 1; *Phoxichilidium*, 2; *Anoplodactylus*, 1; *Ammothea*, 1; *Nympthon*, 4. The species are all illustrated. v.

9. *Proceedings of the United States National Museum*, 1878. Vol. I. 8vo. Washington, D. C.—We have received the first seven signatures of this new serial, which, in general character, resembles the Proceedings of the various learned societies, and contains both brief and somewhat lengthy articles on a variety of zoölogical subjects. Among the articles are several by Mr. W.

* See Report on Invertebrate Animals of Vineyard Sound and adjacent waters, in first Report of U. S. Commission of Fish and Fisheries, 1873, p. 421.

H. Dall, on shells, recent and fossil, mostly of the Pacific coast; several by Mr. G. Brown Goode, and T. H. Bean on Fishes, including a number of additions to the United States fauna; one on the fishes from the Clackamas River, Oregon, by D. S. Jordan; on the birds of Dominica, by G. N. Lawrence; a review of the American species of the genus *Scops*, by Robert Ridgway; on the voices of the Crustacea, by G. Brown Goode. v.

10. *Report on the Hydroida collected during the exploration of the Gulf Stream, by L. F. De Pourtales;* by Geo. J. Allman. Memoirs of the Mus. of Comp. Zoology. Vol. V, No. 2. 66 pp. 4to, with 34 lithographic plates.—In this work a large number of very interesting new genera and species are described and profusely illustrated. The total number of species is seventy-one, of which sixty-four are described as new, the remaining seven being regarded as identical with European or arctic species. The *Plumularidæ* are particularly numerous, comprising twenty-eight species, of which twenty-six are new. Seventeen species occurred in less than fifty fathoms; thirteen between fifty and one hundred fathoms; sixteen between one hundred and two hundred; eight between two hundred and four hundred; and four between four hundred and six hundred fathoms. v.

V. Miscellaneous Scientific Intelligence.

1. *Report on Bridging of the River Mississippi between Saint Paul, Minn., and St. Louis, Mo.;* by Brevet Major General G. K. Warren, Major of Engineers. 232 pp. 8vo, with many maps. Washington, 1878.—This Report, after a prefatory chapter on the origin and nature of the investigation of which it treats, gives, in Chapter II, a general account of the Mississippi and Minnesota River Valleys, with maps illustrating the former drainage of Lake Winnipeg southward through these valleys; and in the following chapters, various details connected with the subject of bridging the river. The larger part of Chapter II, which has great geological interest, will be reproduced in another number of this Journal, together with the maps which relate to it.

2. *Report of the Survey of the Connecticut River*, made to the Secretary of War, by Brevet Maj. General G. K. Warren. 144 pp. 8vo. 1878.—This valuable document consists mainly of the Report of General Theodore G. Ellis, who had charge of the work under General Warren. General Warren, in his preliminary statements, observes that the velocity observations made in the course of the survey (numbering at Thompsonville 1,434) confirm fully the deduction of Humphreys and Abbott (given in their Physics and Hydraulics of the Mississippi) as to the parabolic form of the curve of subsurface velocities. The maximum discrepancy between the requirements of the Humphreys and Abbot formula and the observations is only seven-hundredths of a foot per second. The observations are given in detail in General Ellis's Report, which follows; and as they were made with great

care, and without prejudice in favor of the conclusion reached, they are of the highest importance in the department of hydraulics.

General Ellis also gives the observations made with reference to the monthly and annual discharge of the Connecticut. These observations were carried forward at Hartford, which, although over forty miles from Long Island Sound, is reached by the tides, the amount of tide at the lowest water being about ten inches in range. This discharge for the year 1876 and 1877 was as follows:

	1876. Millions of cubic feet.	1877. Millions of cubic feet.
January	79,956	17,500
February	64,400	18,491
March	93,866	95,253
April	160,756	110,247
May	155,521	45,374
June	41,008	10,907
July	22,016	25,475
August	16,674	22,146
September	17,186	18,089
October	16,930	31,772
November	20,822	75,825
December	17,156	46,382
	700,291	516,261

The highest known freshet on the Connecticut below Holyoke is stated to have occurred in May, 1854, when the water at Hartford gauge stood twenty-nine feet ten inches above low-water mark. The next highest on record—that of 1801—carried the waters up to twenty-seven feet six inches.

The report contains also the results of borings near the Connecticut River Channel at Hartford and to the north up to twenty-five miles. At Hartford and two-thirds of a mile north the depth reached was fifty feet below low water and in the latter case "hard red marl" was struck; at a point 1·56 miles north of Hartford, a boring of 90 feet ended in clay; 2·39 miles north, one of 123·4 feet reached, probably, rock; at 3·37 miles north, rock was reached in 21·11 feet; and at 4½ miles north, rock was reached in 34·8 feet.

3. *Translation of Weisbach's Mechanics.*—The second part of Vol. II of this translation by Professor DuBois (8vo, viii and 559 pp.), contains a full discussion of the important subjects of Heat, Steam and Steam Engines. The first part on Hydraulics and Hydraulic Motors appeared about a year ago (this Journal, xv, 78). Numerous additions to the original work have been made in the form of notes. These are largely by Mr. Richard H. Buel, and are given in order to complete the work in those directions in which there has been recent progress, and to adapt it more fully to American practice.

The third and final volume of Professor Weisbach's great work is now undergoing thorough revision in Germany by Professor Hermann, and its translation will be issued by the publishers

(Wiley & Sons) about the time of the completion of the German revision.

4. *Report of the Superintendent of the Coast Survey, showing the progress of the Survey during the year* 1875. 412 pp. 4to, with thirty charts.—Among the twenty Appendices may be mentioned: Report on Mount Saint Elias, Alaska, by Wm. H. Dall; No. 11, Report on recent observations at South Pass Bar, Mississippi River; Discussion of Tides in New York Harbor, by Wm. Ferrel; Report on the Transit of Venus Expedition to Japan, 1874, by George Davidson; Report on the Transit of Venus Expedition to Chatham Island, 1874, by Edwin Smith; Terrestrial Magnetism, Instructions for magnetical observations, by C. A. Schott.

5. *Eleventh Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology.* Presented to the President and Fellows of Harvard College, September, 1872. Vol. II, No. 2. 458 pp. 8vo. Cambridge, 1878.—This Report contains several memoirs of special value. The first is a Second Report by C. C. Abbot, on the "implements found in the Glacial Drift of New Jersey, occupying over 30 pages. This is followed by others on Cave Dwellings in Utah, Manufacture of soapstone pots by the Indians of New England, Archæological explorations in Tennessee, and other papers of great interest.

6. *A History of the Growth of the Steam Engine;* by R. H. Thurston, A.M., C.E. 490 pp. 8vo. New York, 1878. (D. Appleton & Co., International Science Series.)—A thoroughly readable and instructive discussion of a most interesting subject. The concluding chapter on the "Philosophy of the Steam Engine" gives a concise statement of an important branch of thermodynamics in accordance with modern principles.

7. *Elementary Quantitative Analysis;* by Alexander Classen, Professor in the Royal Polytechnic School, Aix la Chapelle. Translated with additions by Edgar F. Smith, A.M., Ph.D. 328 pp. 8vo. Philadelphia, 1878. (Henry C. Lea.)—In this work the methods of separation required in quantitative analysis are taught by means of examples. The directions for the successive steps in each analysis are given with care and minuteness, and will be found of great value to the student.

8. *The American Quarterly Microscopical Journal, containing the Transactions of the New York Microscopical Society.* Vol. I, No. I. 82 pp. 8vo.—The first number of this new scientific Quarterly, issued under the auspices of the New York Microscopical Society, bears throughout evidence that the Journal will be a valuable record of new discoveries, memoirs, and works in the science to which it is devoted. It contains papers by J. D. Hyatt, H. L. Smith, F. B. Hine, W. H. Seaman, W. T. Belfield, W. Lighton, E. Percival Wright, besides miscellaneous notices and reviews, and is illustrated by seven excellent plates. We commend the Journal strongly to all who are interested in scientific discovery and progress. A very large part of this progress in

recent years has come through microscopic investigation and the same source still continues to be prolific in the profoundest of discoveries.

Mémoires sur les Terrains Cretacé et Tertiaires preparés par feu ANDRÉ DUMONT, pour servir à la description de la Carte Géologique de la Belgique. edités par MICHEL MOURLON, Conservateur au Museé d'Hist. Nat. Tome II Terrrains Tertiaires, Première Patrie. 440 pp., 8vo. Bruxelles, 1878.

OBITUARY.

THOMAS BELT.—Mr. Thomas Belt, F.G.S., of London, England, died in Kansas City, Missouri, on Saturday, September 28. Mr. Belt had been for some time past actively at work in Colorado, looking after the mining interests of some English company. During the same time he has made some interesting notes of the Drift of that State, and in a letter to the writer in August, he informed him of the discovery of a skull of a human being in the Drift, the details of which he was engaged in studying and working out. He was engaged in preparing a paper to be presented to the American Association at the St. Louis meeting, on the subject of the above-named skull, but did not complete his study in time. He has written many valuable papers on geology, especially on glaciers, and also an interesting volume, entitled "The Naturalist in Nicaragua," continued the result of his observations of over two years in that country. One of his papers is on the retrocession of Niagara Falls.

About two weeks previous to his death he had shown signs of insanity, and it was thought best to remove him to New York. Mr. Silas Lloyd, who had been for a short time associated with him, accompanied him. Just before arriving at Kansas City, Mr. Lloyd had occasion to leave him for a few minutes. On returning, he found the door locked. Mr. Belt refused to let him in, and commenced a furious onslaught on furniture and car. Parties crawled through the broken windows and succeeded in pacifying him. Getting him off the train, he was prevailed upon to drink a glass of milk, and about twenty minutes afterward he died.

G. C. BROADHEAD.

Dr. E. v. ASTEN; M. E. QUETELET; THOMAS GRUBB.—Astronomy has recently lost several able men by death. One of these was Dr. E. von Asten, who was attached to the Pulkowa Observatory, and who has carried on the discussion of the observations and orbit of Encke's comet since Professor Encke's death. He died August 15th, at Kiel, aged 36. Another loss is that of M. E. Quetelet on the 6th of Sept., at Ixelles at the age of 53. He was assistant at the Brussels Observatory for more than twenty years, the direction of which practically fell on him. One of his many important contributions to science was on the proper motions of certain stars. Mr. Thomas Grubb, the maker of the large Melbourne reflector, and of numerous other large reflectors and refractors, died Sept. 19, in the 78th year of his age.

Dr. AUGUST HEINRICH PETERMAN.—Dr. A. H. PETERMANN, the learned geographer, and editor or the "Mittheilungen," died at Gotha, Germany, on the 27th of September, at the age of fifty-six.

APPENDIX.

ART. XLIV.—*Principal Characters of American Jurassic Dinosaurs;* by Professor O. C. MARSH.
Part I. With seven Plates.

ON the flanks of the Rocky Mountains, a narrow belt of strata can be traced for several hundred miles, marked always by the bones of gigantic Dinosaurs. Its position is above the characteristic red Triassic beds, and immediately below the hard sandstone of the Dakota group. Hayden, Cope and others have regarded this horizon as Cretaceous, but the abundant vertebrate remains now known from it prove its Jurassic age beyond a reasonable doubt. The writer examined a typical outcrop of this series, on the western slope of the mountains in Wyoming, in 1868, and determined it to be Jurassic; and he has recently named the series the Atlantosaurus beds, from the most striking vertebrates they contain. The strata consist mainly of estuary deposits of shale and sandstone, and the horizon is clearly upper Jurassic, as shown in the accompanying section (Plate IV.)*

Besides the Dinosaurs, which are especially abundant, numerous remains of Crocodilia (*Diplosaurus*), as well as Tortoises and Fishes (*Ceratodus*), have been found, and with them a single Pterodactyle (*Pterodactylus montanus*).† The small Marsupial (*Dryolestes priscus*) recently described by the writer was discovered in the same beds.‡

The remains of *Dinosauria* in this series of strata are mostly of enormous size, and indicate by far the largest land animals hitherto discovered. *Atlantosaurus immanis* must have been at least eighty feet in length, and several others nearly equaled it in bulk. With these monsters occur the most diminutive Dinosaurs yet found, one of them (*Nanosaurus*) being about as large as a cat. The herbivorous Dinosaurs now known from these beds are of special interest, and represent two distinct groups, the more important characters of which are given in the present article.

* This section was especially designed to illustrate an Address by the writer, on The Introduction and Succession of Vertebrate Life in America. This Journal, vol. xiv, p. 337, Nov., 1877.

† This Journal, vol. xv, p. 233, Sept., 1878.

‡ This Journal, vol. xv, p. 412, June, 1878.

Sauropoda.

A well marked group of gigantic Dinosaurs from the above horizon has been characterized by the writer as a distinct family, *Atlantosauridæ*, but they differ so widely from typical *Dinosauria*, that they belong rather in a suborder, which may be called *Sauropoda*, from the general character of the feet. They are the least specialized of the order, and in some characters show such approach to the Mesozoic Crocodiles, as to suggest a common ancestry at no very remote period.

The most marked characters of this group are as follows:

1. The fore and hind limbs are nearly equal in size.
2. The carpal and tarsal bones are distinct.
3. The feet are plantigrade, with five toes on each foot.
4. The precaudal vertebræ contain large cavities, apparently pneumatic.
5. The neural arches are united to the centra by suture.
6. The sacral vertebræ do not exceed four, and each supports its own transverse process.
7. The chevrons have free articular extremities.
8. The pubes unite in front by ventral symphysis.
9. The third trochanter is rudimentary or wanting.
10. The limb bones are without medullary cavities.

Of this suborder, *Sauropoda*, four genera are well represented in the Museum of Yale College, and others, apparently closely allied, are indicated by remains from this country and Europe described by various authors. The genera *Atlantosaurus*, (*Titanosaurus*),* *Apatosaurus* and *Morosaurus*, have already been described by the writer, and with the new genus *Diplodocus*, defined below, are the most characteristic American representatives of this group. Of these, *Morosaurus* is known from a large number of individuals, including one nearly complete skeleton, and hence, in the present communication, this genus will be mainly used to illustrate the group.

Morosaurus, Marsh, 1878.

The head in this genus was very small. The skull shows in its fixed quadrates and some other features a resemblance to that in the Crocodiles. The rami of the lower jaw are not united by symphysis. The teeth are numerous, and their general form is shown in Plate V, figures 1 and 2. The neck was elongated, and, except the atlas, all the cervical vertebræ have deep cavities in the sides of the centra, similar to those in birds of flight. (Plate V, figures 3 and 5). They are also strongly opisthocœlous. The atlas and axis are not ankylosed together, and the elements of the atlas are distinct. The supero-lateral pieces unite with the axis by zygapophyses, (Plate V, figure 4, *z*).

* This Journal, xiv, pp. 87, 514; xv, pp. 241.

The dorsal vertebræ have elongated neural spines, and deep cavities in the sides. They are distinctly opisthocœlous. There are four vertebræ in the sacrum, all with cavities in the centra. Their transverse processes are vertical plates, with expanded ends. The anterior caudal vertebræ are plano-concave, and nearly or quite solid. The tail was elongated, and the chevrons are similar to those in Crocodiles.

The scapula is elongated and very large, and has a prominent anterior projection. The coracoid is small, suboval in outline, and has the usual foramen near its upper border. These two bones are well represented in Plate VI, nearly in the relative position in which they were found. The humerus is very large and massive, and its radial crest prominent. This bone is nearly solid, and its ends were rough, and well covered with cartilage. This is true also of all the large limb bones in this genus. The radius and ulna are nearly equal in size. The carpal bones are separate, and quite short. The five metacarpals are short and stout, and the first is the largest. The toes were thick, and the ungual phalanges were evidently covered with hoofs. In Plate VII, figure 1, the restoration of the scapular arch and entire fore limb of one species of *Morosaurus*, well illustrates this part of the skeleton.

The pelvic bones are distinct from each other, and from the sacrum. The ilium is short and massive, and shows on its inner side only slight indications of its attachment to the sacrum. More than half of the acetabulum is formed by the ilium, which sends down in front a strong process for union with the pubis, and a smaller one behind to join the ischium (Plate VIII, figure 1, *a* and *b*). The acetabulum is completed below by the pubis and ischium. The pubis is large and stout, and projects forward and downward, uniting with its fellow on the median line in a strong ventral symphysis. Its upper posterior margin meets the ischium, and contains a large foramen. The ischium projects downward and backward, and in *Morosaurus* its distal end is not expanded for a symphysis. The relative position and general form of the three pelvic bones in this genus are shown in Plate X, figure 3.

The femur is long and massive, and without a true third trochanter, although a rugosity marks its position. The great trochanter is obtuse, and placed below the head. The ridge which plays between the tibia and fibula is distinct. The tibia is shorter than the femur. It is without a spine or fibular ridge, and its distal end shows that the astragalus was separated from it by a cushion of cartilage. The fibula is stout, its two extremities nearly equal, and its distal end supports the calcaneum. The two tarsal bones of the second row are short, and the five well-developed digits are similar to those in the manus. The first metatarsal is much the largest. (Plate VII, figure 2.)

The largest species of this genus at present known may be called *Morosaurus robustus*. It can readily be distinguished from those already described by its short, helmet-shaped, ilium, which is represented in Plate VIII, figures 1 and 2.

One species of this genus, *Morosaurus grandis*,* is now known by a nearly complete skeleton, and the remains here figured are mainly portions of this individual. They were found together in nearly as perfect preservation as in life, and many of them were in their natural position. The locality was in Wyoming, and the bones were taken out with great care by Mr. S. W. Williston of the Yale Museum.

This animal when alive was about forty feet in length. It walked on all four feet, and in many other respects was very unlike the typical Dinosaur. It must have been very sluggish in all its movements. Its brain was proportionately smaller than in any known vertebrate.

Diplodocus longus, gen. et sp. nov.

This genus includes some Dinosaurs of very large size, and herbivorous in habit. It may be distinguished from the genera already known by the caudal vertebræ, which are elongated, deeply excavated below, and have double chevrons, with both anterior and posterior rami. (Plate VIII, figures 3 and 4). To the last character, the generic name refers. The tibia, also, is a very characteristic bone, as it is deeply grooved above to receive the fibula. The feet in this genus are very similar to those of *Morosaurus*, shown in Plate VII.

The present species is based upon one posterior limb, and the tail, of a single individual. The limb, as extended before removal, measured from the head of the femur to the end of the toes over thirteen feet (4·1^{M}). The femur was 1645^{mm} in length, and the tibia 1090^{mm}. Four of the median caudal vertebræ measured together thirty-four inches (760^{mm}). The first of these, or the fourteenth in the series, was eight and one-half inches (217^{mm}) long, and five and one-half inches (140^{mm}) across the anterior end.

The peculiar chevron represented in Plate VIII, figure 3, was found attached to the eleventh caudal, and all the remaining chevrons observed were of this character. Figure 4 represents a specimen found at another locality, and perhaps belonging to a different genus.

The above remains indicate a reptile about fifty feet in length. They were found in the upper Jurassic, near Cañon City, Colorado, in 1877, by Mr. S. W. Williston.

* This species, when described by the writer, was referred provisionally to the genus *Apatosaurus*. This Journal, vol. xiv, p. 515.

Laosaurus Marsh, 1878.

Another well marked group of herbivorous Dinosaurs, mostly of small size, occur in the same deposits with the gigantic forms above described. These belong to a separate suborder, and among the typical *Ornithoscelida*, as defined by Huxley. They belong also to the *Iguanodontidæ*, and most nearly resemble the genus *Hypsilophodon*, from the Wealden of England. All the specimens known from the Atlantosaurus beds appear to come under the genus *Laosaurus*, several species of which have already been found, represented by numerous individuals. One of the species hitherto undescribed may be called *Laosaurus altus*, and its remains, with those of the smaller *Laosaurus celer*,* are here used to define the characters of the genus.

The skull is of medium size, and, so far as its structure has been made out, resembles that of *Hypsilophodon*. The teeth, also, are very similar (Plate IX. figures 2 and 3.) The rami of the lower jaw are edentulous in front, and apparently were not united by symphysis. The dorsal and caudal vertebræ have their extremities nearly plane, and the neural arches are united to the centra by suture. The chevrons have their articular ends joined together, as in *Iguanodon* and most Dinosaurs.

The fore limbs were quite small, less than half as long as the hind limbs, and evidently were not much used in locomotion. The humerus is slender, and considerably curved. The radius and ulna are nearly of the same size. In this species, the humerus is 190^{mm} long, and the radius 150.

The bones of the pelvis are distinct. The outline of the ilium is not known, but the pubes and ischia of several individuals have been determined, and prove of great interest. The pubis forms the antero-inferior part of the acetabulum, and the ischium completes the lower portion. The pubis extends downward and inward in front, and terminates in a broad spatulate free extremity. It unites with the ischium below the acetabulum, and sends backward and downward a long slender ramus, which is clearly homologous with the so-called pubic bone in birds (Plate X, figure 2). There is a large foramen near the ischiadic margin. This foramen is closed behind by suture only, and in some specimens becomes a notch. The posterior, rodlike, ramus ossifies from an independent center, and, to distinguish it from the true reptilian pubis in front, may be called the post-pubic bone. A comparison of the three pelves represented together in Plate X (*Hesperornis*, *Laosaurus* and *Morosaurus*), will make clear the intimate relation existing between the pubic bones of Birds and Dinosaurian reptiles.† If this series be extended by adding

* This Journal, xv, 244, March, 1878.

† After these figures were made, showing the position of the Dinosaurian pubis, which has caused so much discussion since Cuvier, I found that Dr. J. W. Hulke had already suggested the true solution of one difficulty. (Journal Geological Society of London, vol. xxxii, p. 334.)

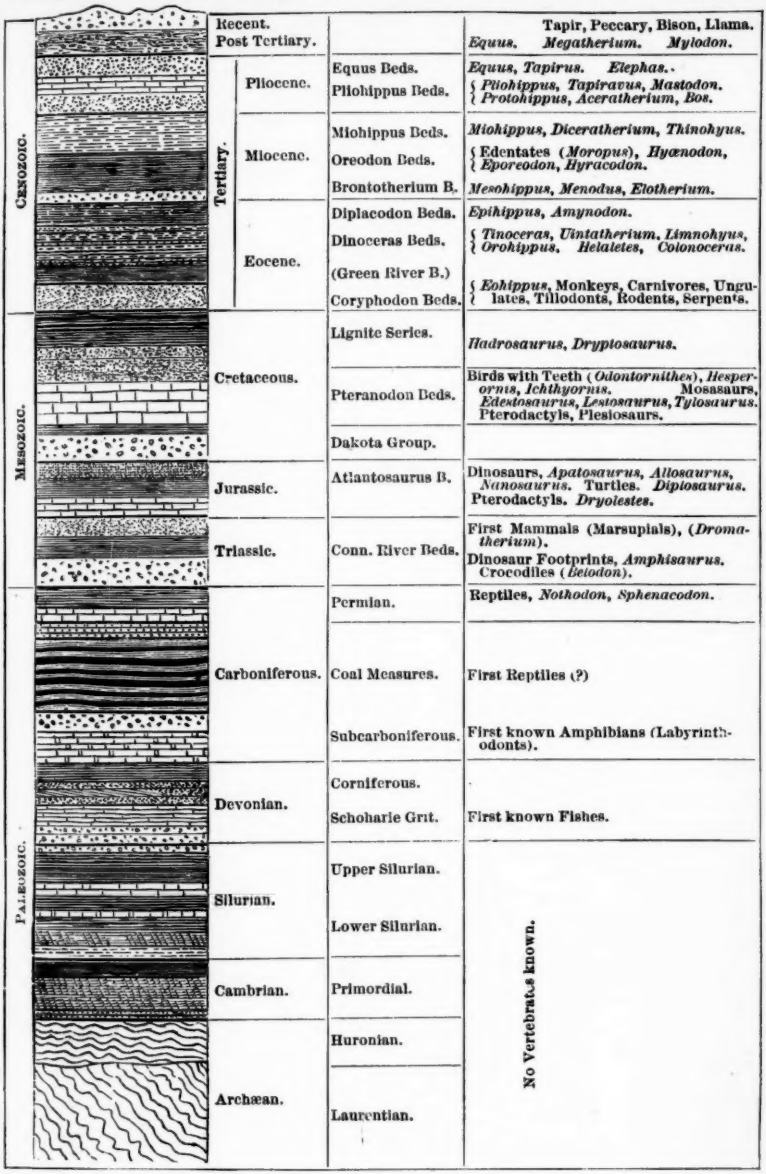
the pelves of some existing birds (for example *Geococcyx*), and of a few other reptiles, it will become still more evident that the bone called "pubis" in a bird, is a different bone from the pubis of a crocodile. The ischium in *Laosaurus* is a slender bone, extending backward parallel with the post-pubic. It has a distinct obturator process, which laps over the latter bone.

The limb bones in this genus have a distinct medullary cavity. The femur has a prominent great trochanter, the extremity of which is separated from the neck by a fissure. The third trochanter is long, and curved outward. The tibia slightly exceeds the femur in length, the proportions in *Laosaurus altus* being 393 to 360^{mm} (Plate IX, figure 3). The fibula is slender, and the distal smaller than the proximal end. The astragalus is distinct from the tibia, and the calcaneum supports the fibula. There are but two tarsals in the second row. There are three well developed digits in the pes (II, III and IV). The outer, or fifth, is wanting, and the first, or hallux, is represented only by a remnant of the metatarsal. The phalanges are rather short, and the ungual ones are pointed. (Plate IX, figure 3.)

The remains of this genus at present known are all from the Atlantosaurus beds of Colorado and Wyoming. Those here described were found in Wyoming by Mr. S. W. Williston. They represent an animal of slender proportions, and about ten feet in length.

Yale College, New Haven, October, 1878.

[To be continued.]



SECTION OF THE EARTH'S CRUST.

TO ILLUSTRATE VERTEBRATE LIFE IN AMERICA.

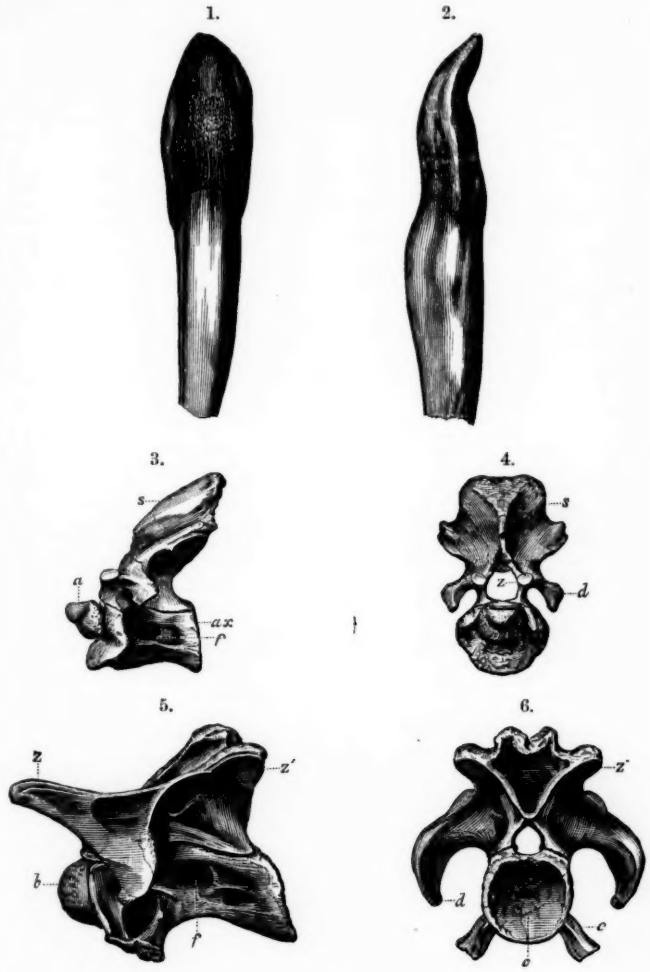


Figure 1.—Tooth of *Morosaurus grandis* Marsh; side view.
Figure 2.—The same; front view. Both one-half natural size.
Figure 3.—Axis and part of atlas of *Morosaurus grandis;* side view, one-eighth natural size. *a.* odontoid process, or centrum of atlas; *ax.* centrum of axis; *f.* foramen in centrum; *s.* neural spine.
Figure 4.—The same; front view. *d.* diapophysis; *z.* zygapophysis.
Figure 5.—Fourth cervical vertebra of *Morosaurus grandis;* side view, one-eighth natural size. *b.* ball on anterior end of centrum; *f.* foramen in centrum; *z.* anterior zygapophysis; *z'.* posterior zygapophysis.
Figure 6.—The same; back view. *c.* cup on posterior end of centrum; *d.* diapophysis; *e,* parapophysis; *z'.* posterior zygapophysis.

Left scapula and coracoid of *Morosaurus grandis* Marsh; side view; one tenth natural size. *a.* scapular face of glenoid cavity; *b.* rugose surface of scapula for union with coracoid; *a'.* coracoidean part of glenoid cavity.

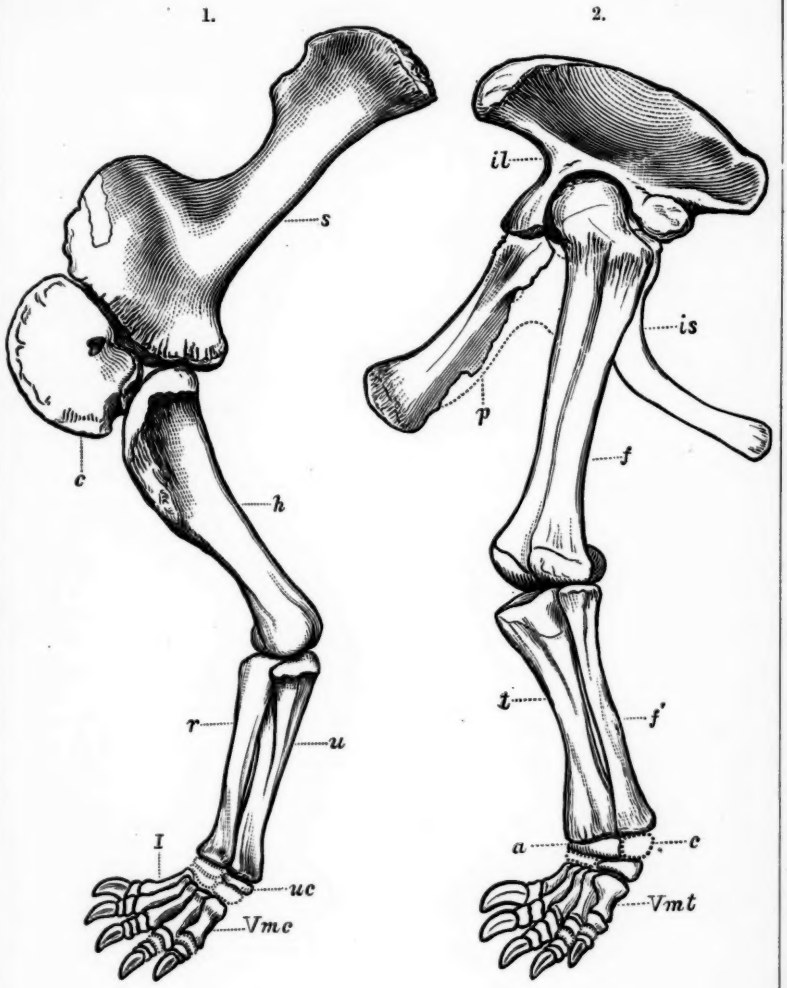


Figure 1.—Bones of left fore leg of *Morosaurus grandis* Marsh; one-twentieth natural size; *s.* scapula; *c.* coracoid; *h.* humerus; *r.* radius; *u.* ulna; *uc.* ulnar carpal; *I.* first metacarpal; *Vmc.* fifth metacarpal.

Figure 2.—Bones of left hind leg of *Morosaurus grandis;* one-twentieth natural size. *il.* ilium; *is.* ischium; *p.* pubis; *f.* femur; *t.* tibia; *f'.* fibula; *a.* astragalus; *c.* calcaneum; *Vmt.* fifth metatarsal.

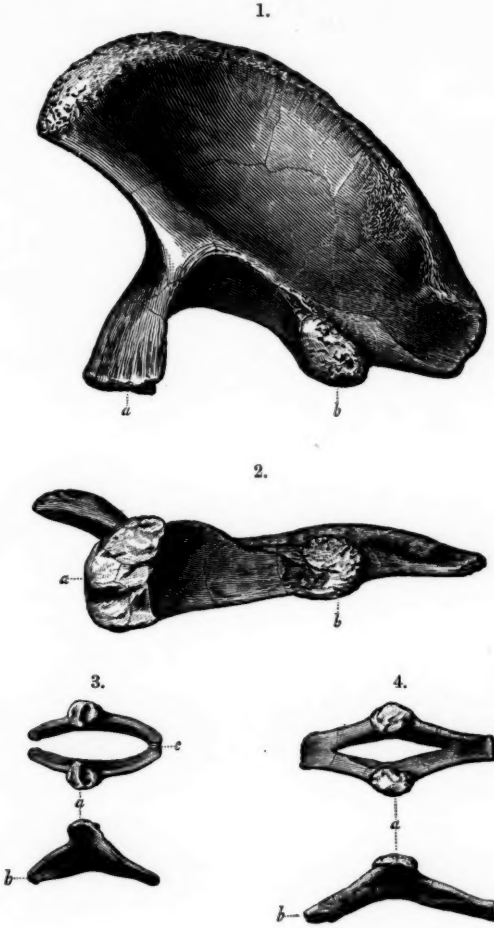


Figure 1.—Left ilium of *Morosaurus robustus* Marsh; side view. *a.* anterior, or pubic, articular surface; *b.* posterior, or ischiadic, articular surface.
Figure 2.—The same; inferior view. *a*, anterior, or pubic, articulation; *b.* posterior, or ischiadic, articulation. Both figures one-tenth natural size.
Figure 3.—Chevron of *Diplodocus longus* Marsh; top and side views. *a.* articular surfaces; *b.* anterior process; *c.* posterior process.
Figure 4.—Chevron of another individual; letters the same as in figure 3. All the figures are one-tenth natural size.

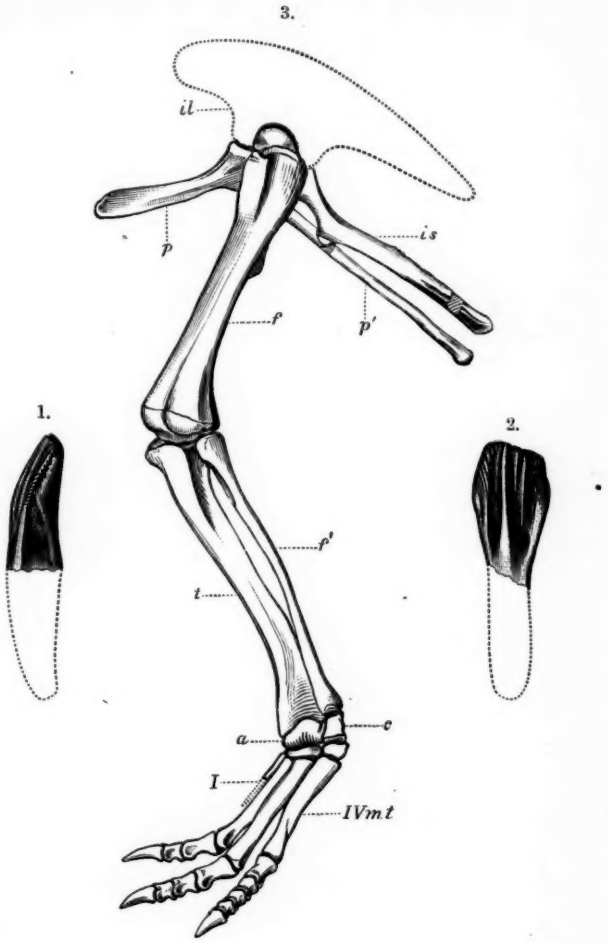


Figure 1.—Tooth of *Laosaurus altus* Marsh; front view.
Figure 2.—The same, side view. Both twice natural size.
Figure 3.—Bones of the left hind leg of *Laosaurus altus* Marsh; one-eighth natural size; *il.* ilium; *is.* ischium; *p.* pubis; *p'.* post-pubic bone; *f.* femur; *t.* tibia; *f'.* fibula; *a.* astragalus; *c.* calcaneum; *I.* first metatarsal; *IVmt.* fourth metatarsal.

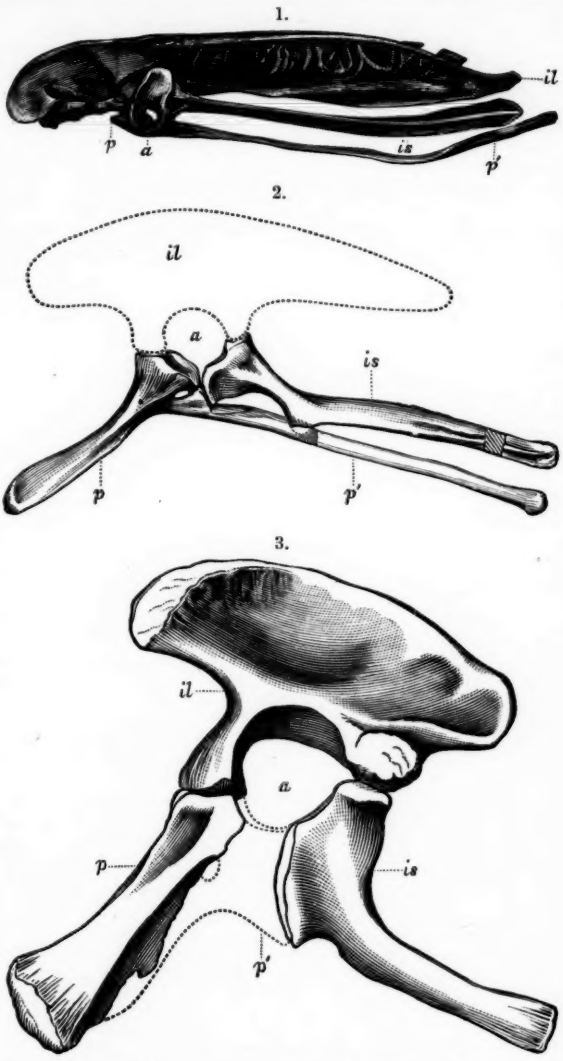


Figure 1.—Pelvis of *Hesperornis regalis* Marsh (Cretaceous); seen from the left, one-fifth natural size.

Figure 2.—Pelvis of *Laosaurus altus* Marsh; seen from the left, one-sixth natural size.

Figure 3.—Pelvis of *Morosaurus grandis* Marsh; seen from the left, one-sixteenth natural size.

The signification of the letters is the same in all the figures, viz: *a.* acetabulum; *il.* ilium; *is.* ischium; *p.* pubis; *p'.* post-pubis.